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November 1, 1950

Bi-State Development Agency
Room 1420 - 915 Olive Street
St. Louis 1, Missouri

Gentlemen:

Pursuant to the agreement between the Agency and our office, we are herewith presenting our detailed report covering the survey of and recommendations with respect to the matter of sanitary sewerage and drainage facilities for the City of St. Louis and the urbanized portion of St. Louis County roughly described as follows: the area lying between the city limits of St. Louis and a line following Lindbergh Blvd. from its southerly limits to about Highway 66 to Olive Street Road, Lindbergh Blvd. to Lambert Field, and north of Lambert Field all of St. Louis County except the fringe drainage along the Missouri River bluffs.

The presently detailed report, herein transmitted, has been divided into two parts: Part I covering the description of the present and required sanitary facilities with a master plan for such facilities; and Part II covering the existing and required storm water drainage facilities. The subject of sanitation, especially, and drainage in the St. Louis County area has been one of general concern for a number of years as indicated in the following historical description.

Section I - Historical Background and Present Legislation;

Before discussing suggested legislation and recommendation for establishment of an agency or agencies or revision of the present laws to permit the

construction of an integrated program of sanitary sewerage facilities, there is herewith presented a review of previous plans, reports of committees, and present legislation.

As shown in this detailed report, the City of St. Louis is completely served with combined sewers adequate for the sanitary sewerage requirements for the ultimate population and foreseeable development within the city. The problem therefore of inadequate sanitary sewerage facilities is primarily a County problem, which has become aggravated as the population of the County has increased. The areas adjacent to the City of St. Louis, generally within incorporated municipalities, and northwardly from the junction of the Deer Creek Branch of the River Des Peres were the first to be served with combined facilities connected with the City of St. Louis sewers at the city limits. As the development continued away from the city limits throughout the County, sanitary sewer facilities were local in character, not integrated, and the sewage was discharged into the natural water courses, most of which have no flow except during periods of rainfall. The continued growth during the 20's, after the first world war, created serious unsanitary conditions which required solution. Civic organizations and health authorities, as well as public agencies, recognized the need for legislation to abate and clean up these unsanitary conditions. This resulted in the first action of the legislature in the passage of the so-called Ralph Sewer Law.

Ralph Sewer Law: In the late 20's the State Legislature passed what is known as the Ralph Sewer Law, which resulted in general in the preparation of detailed plans of combined sewerage facilities for the County. This law specified that the cost of the proposed improvements was to be spread against the benefited property in accordance with the benefits determined by Commissioners appointed by the Court. With the publication of the benefits, the reaction of the public was such that the Ralph Sewer Law was repealed,

leaving the County without workable legislation to provide sanitary sewerage facilities except by the establishment of special tax districts.

Present Sewer Law: The continued growth of the County, with the serious pollution of all open water courses finally resulted in the formation of a representative committee in St. Louis County who sponsored the present sewer law under which all of the existing sewer districts were formed and under which most of the recent sewer work was carried out. This law permits the incorporation of sewer districts to embrace both unincorporated and incorporated municipal areas, so that districts can be formed for all of those portions of the watersheds where sanitary sewers are necessary.

St. Louis County District: Immediately upon the passage of the present sewer district law, preliminary plans and estimates of cost were prepared for trunk sanitary sewers for the entire urbanized area of St. Louis County, which embraces practically the area analyzed in this report. At the time of the hearing for this County district, Federal aid was available in the form of grants from the Public Works Administration. Tentative approval of the grant on this project was obtained and was recognized in the estimated cost forming the basis of the amount of bonds to be voted by the taxpayers of the districts. The election ordered by the Circuit Court following the incorporation of the District failed to result in the two-thirds affirmative vote required for incurring the bonded debt.

Present Sewer Districts: With the failure of the St. Louis County District, the more densely populated and higher valued areas immediately took steps to organize sewer districts under the law for smaller separate areas. Later there followed incorporations of other districts throughout the County, resulting in the numerous sewer districts that now exist in St. Louis County as shown on Fig. 2. These sewer districts, aided by funds received from the Federal Government during the depression years in the 30's, administered all

of the sanitary sewer construction which has taken place, with the exception of the construction entirely within incorporated municipalities.

Effect of End of Federal Aid: Since Federal aid stopped in 1941, all activities of the sanitary districts also stopped, with the exception of the Ladue-Deer Creek Sanitary Sewer District, as the limitation of 5 per cent of the assessed valuation generally does not provide sufficient funds to completely construct even the system of trunk sanitary sewers necessary. With the cessation of W.P.A., such districts as the Normandy District were left with a partially completed collecting sanitary sewerage system with no treatment; the Garsonville Sewer District has a collecting system which was later extended with Lanham Act funds, but a treatment plant partially constructed and not functioning, with the raw sewage discharging into Maline Creek; the Wellston Sewer District, which authorized issuance of bonds in the amount of \$460,000, has had complete plans prepared for a combined system of sewers now estimated to cost approximately two million dollars, but has not issued the bonds nor started construction, as sufficient funds are not available to complete the system.

Coordination between Districts: Fortunately, however, the sewers that have been constructed by the sewer districts have generally been made of sufficient size and have been coordinated in instances by a number of districts and municipalities to provide adequately for the population expected in the watershed tributary thereto. Also, fortunately it has been possible to contract with the City of St. Louis for connection charges based upon the use of the City sewers for sanitary sewage flow only. This situation has not existed in the watersheds requiring trunk facilities directly into the Mississippi River, which are the areas presently in need of the recommended plans herewith submitted. *Missouri River*

Federal Aid from Lanham Act Funds: During the second world war period, when Federal aid was available for construction of public facilities in areas containing industries engaged in production necessary for war needs, and where a war-connected need could be established for the construction of sanitary sewers, the St. Louis County Court made application for Federal funds for the construction of a comprehensive system of sanitary sewers in the unsewered areas in St. Louis County. The Federal Works Agency, having the jurisdiction of the allotment of the so-called Lanham Act funds apparently decided that the needs of the County for adequate sanitary sewer facilities were of long origin not resulting from new war plant construction, and therefore not falling within the category of a war-connected need. Federal aid in the form of Lanham Act funds was made available in certain instances to complete work already started, and made possible with previous Federal aid the completion of the Walton Road District collecting system and sewage treatment plant, and the additional construction of collecting sewers in the Carsonville Sewer District.

St. Louis County Court Committee: The County Court recognizing that a solution for the construction of sanitary trunk sewer facilities, as well as storm facilities, was paramount in St. Louis County, appointed a Committee composed of representatives of the existing sewer districts, municipalities, attorneys and engineers to study the problem, and to submit recommendations for suggested legislation to the State Legislature. This committee deliberated during 1947 and 1948, and submitted recommendations for amendments to the present sanitary sewer district law and for the passage of an enabling act to permit the establishment of an overall district which would be granted the powers necessary to develop and maintain a satisfactory sanitary conditions in St. Louis County. The amendments suggested to the present sanitary sewer district law were introduced in the legislature in 1949 but failed of passage.

Essentially most of the ambiguities in the present law

1. A change in the boundary
2. The modification and ex
3. The presentation of elec
- valuations have increased to perm
4. Amendment of the sewer di
- Bonds to be issued up to 10 per ce
- property instead of the present 5 p
- requires a vote to amend the presen

The suggestions of this St. Lou
the recommendation that an enabling
permit the establishment of an overal
minister the construction of both san
ties. It was recommended that this di
nominal tax **annually** for aid to areas
limitations would not enable the financing of the necessary sanitary facil
ties. (A copy of this County Court Sewer Committee report is being filed
separately with the Bi-State Development Agency.)

Sewer Rental Bonds: It has also been suggested that the State Legisla
ture amend the present sewer laws to permit municipalities and sewer districts
to finance sewer construction from the proceeds of the sale of sewer revenue
or sewer rental bonds. The State of Missouri is one of the few states that
does not permit financing of sewer construction by Sewer Rental or Sewer Reve
nue Bonds. Commencing with the time of the Public Works Administration, when
this agency encouraged legislation throughout the country for Sewer Rental
issues to finance sewer construction, the County Court, municipalities, sewer
districts and civic organizations have repeatedly urged the State Legislature

to pass such legislation. The new constitution of the State of Missouri grants authority to issue Revenue Bonds for water works, for municipally owned power plants and utilities, but is silent on sewer construction.

New St. Louis County Charter: The present charter, which will go into effect upon election of a new Council on January 1st, grants the authority to establish sewer districts in unincorporated areas only. The new Council will have no authority to levy assessments for sewer construction where such sewers involve watersheds embracing both unincorporated and incorporated municipal areas. The present County Court, however, has recently filed an application with the Bureau of Community Facilities for Federal aid in the preparation of plans for some of the necessary trunk sanitary sewers as recommended in this report.

In connection with this report, we presented to Mr. Carl Trauernicht of Charles & Trauernicht, recognized bond attorneys, a series of questions pertaining to the powers granted to the various agencies administering sewer construction under the present laws. In Appendix C of this report there is included the questions presented to Mr. Trauernicht and the opinions rendered by him on these matters.

Section II - Comments on Detailed Report Herewith Presented - Sanitary Facilities:

With the exception of the River Des Peres foul water sewer, the City of St. Louis is served throughout with a system of combined sewers carrying both sanitary sewage flow and storm water runoff. As a result, the areas within the County adjacent to the city limits and within the common watersheds of County and City areas have also been served with combined sewers.

On Fig. 1 of the report are shown the various natural watersheds embracing the areas which have been surveyed for existing and required facilities. All of the River Des Peres watershed within the City and County above the

Deer Creek junction, and all of the Harlem-Baden watersheds within the City and County are adequately served with sanitary sewerage facilities except for the portion to the north and west of University City in the River Des Peres valley, and at present in University City where the existing foul water sewer is inadequate.

On Fig. 2 are shown, within the watersheds of the urbanized area in the County, the present incorporated municipalities and sewer districts, and in addition the sewered locations in unincorporated areas.

Deer Creek Watershed: It will be noted from this exhibit and from the discussion in Part I of the detailed report that, in general, the area within the Deer Creek branch of the River Des Peres watershed is satisfactorily served with sanitary sewerage facilities except for the following:

1. Area tributary to Two Mile Creek branch within which an adequate system of trunk sanitary sewers has been provided by the Two Mile Creek Sanitary Sewer District, and lateral sewers are being built by the subdividers or owners of land as developments requiring such sewers occur.

2. An area within the Village of Frontenac west of Lindbergh Blvd. and east of Spode Road, which can be served by the construction of sewers connected to the trunk system of the Ladue-Deer Creek Sanitary Sewer District. For the area to the west of Spode and Geyer Roads within the Village of Frontenac, present zoning in general is limited to one-acre tracts which will result in developments which can be properly served by individual treatment plants without a collecting system, making this a local matter.

3. The recently incorporated area of Creve Coeur, if developed in smaller than one-acre tracts, will require construction of a collecting system and high type sewage treatment plant, as the trunk facilities downstream therefrom have not been constructed of sufficient size to serve this area.

Within the Deer Creek watershed now sewerred, it will be noted that an integrated system of sewers has been constructed with its outlet connected at the city limits to the River Des Peres foul water sewer of the City of St. Louis. The present trunk facilities within this watershed are adequate for ultimate development, except for the River Des Peres foul water sewer within the City of St. Louis.

Gravois Creek Watershed: To the south of the Deer Creek branch of the River Des Peres within the County, most of the area lies within the Gravois Creek watershed with the exception of the area adjacent to the city limits of St. Louis between the ridges of the Gravois and Deer Creeks watersheds. In Part I of the detailed report, there is enumerated the existing facilities consisting of collecting systems and sewage treatment plants. The greatest percentage of development has occurred in the upper reaches of the watershed, namely a portion of Kirkwood and the adjacent incorporated communities. In this detailed report, alternate plans were analyzed for the construction of the necessary trunk sanitary sewer facilities, with such facilities by-passing the present treatment plants, or for the construction of the necessary trunk sanitary sewer facilities for the areas not now served with modern treatment plants. As will be noted, the alternate plan of gravity trunk sanitary sewer facilities without treatment plants proved to be the more economical and the more efficient and desirable. This plan is, therefore recommended at an estimated cost, using current prices of \$2,610,000.

The approximate total of current assessed valuation of taxable property within the Gravois Creek watershed is \$23,000,000. If a sewer district for the construction of trunk sanitary sewers were established, a total of \$1,150,000 could be authorized on the basis of 5 per cent of the approximate assessed valuation. In this watershed, therefore, with present valuations

and present constitutional debt limitations pertaining to such a district, the financing of the plan suggested could not be undertaken.

However, if the State Legislature authorizes the issuance of Sewer Rental Bonds, the annual charges based upon present population would not be unreasonable. Such charges, if calculated on assumed increase in population, which undoubtedly would occur shortly after the trunk sanitary facilities were provided, would result in a very low annual charge for the service rendered. Financing of the necessary sanitary facilities, including laterals, would also be feasible under the Sewer Rental Plan.

Maline-Coldwater Creeks Watersheds: Similar detailed studies are presented in the report for both the Maline and Coldwater Creeks watersheds. Separate trunk facilities for each of these watersheds were analyzed with preliminary estimates of cost prepared for each. Inasmuch as the mouth of the Coldwater Creek at the Missouri River is upstream from the City of St. Louis Chain-of-Rocks water plant, an alternate plan for combining the outlet for Coldwater Creek, by means of a tunnel with the Maline Creek trunk, was studied. Under this plan gravity lines would be continued from the upper reaches of the Coldwater Creek valley to the north of the St. Louis Municipal Airport. A separate gravity line is suggested northwardly from the St. Louis Municipal Airport to a point on Coldwater Creek at the north end of the City of Florissant. The present zoning below Florissant is generally on the order of a minimum of one acre per lot, which should not require a collecting system and common treatment. It is, therefore, proposed that a lift station be built at the lower end of the gravity line ending below Florissant to bring the sewage back to the Wabash Railroad right-of-way from which point a connection by means of a tunnel through the ridge between the Coldwater and Maline Creeks watersheds would be necessary with a common outlet for both watersheds constructed along Maline Creek to the Mississippi River. The plan

involving the combined outlet for the two watersheds proved to be the more economical and is therefore recommended.

It will be noted from the summary table that the total estimated cost of the recommended joint outlet sewer for the Maline-Coldwater Creeks trunk sanitary sewerage facilities is estimated to cost \$4,823,000. On the basis of the present assessed valuation of approximately 80 million dollars, it will be possible to obtain the sum of 4 million dollars if an affirmative vote of two-thirds majority is obtained from the voters on a proposition for the construction of the sewers in these watersheds. This amount, as can be seen, is approximately 20 per cent short of the total funds required.

In these valleys also it would be feasible to finance the construction of the trunk sanitary facilities with funds obtained through the sale of Sewer Rental Bonds. The annual charges are sufficiently low, even on the basis of the present population, to make such issues attractive in financial circles.

Other Areas: The master plan as presented in Part I of the detailed report covers the needs and recommendations for trunk sanitary sewer facilities for the presently unsewered areas adjacent to the City of St. Louis between the Gravois and Deer Creeks watershed lines, for the unsewered areas to the north and west of University City in the River Des Peres valley, including the area embraced within the presently incorporated Wellston Sewer District, and for the Watkins Creek watershed lying between Maline and Coldwater Creeks watersheds.

Wellston Sewer District: There has been included in the summary which follows, and in Part I of this report, an estimate of cost for complete sanitary sewerage facilities for the area presently incorporated as the Wellston Sewer District. This area, which probably contains the densest population and industrial development within the County, is sorely in need of a

comprehensive adequate system of sewers. The proceedings in the Circuit Court, which authorized the incorporation of this District, and the engineer's report, which formed the basis of the plan submitted to the voters, provides for a combined system of sewers which apparently is the desire of industry and population in this area. With the present constitutional limitations of 5 per cent of the assessed valuation, sufficient funds could not be raised to defray the cost of a combined system of sewers. There has been set out in this report the estimated cost of a separate sanitary sewerage system only, which is shown in the following summary table. In Part II of the report covering storm drainage facilities, there is also included for the Wellston Sewer District the total estimated cost of a combined system of sewers to serve this portion of the River Des Peres watershed.

River Des Peres Foul Water Sewer: In the most recent bond issue voted by the citizens of the City of St. Louis in 1944, funds were authorized for the construction of the necessary relief sewers for the River Des Peres foul water sewer entirely within the City of St. Louis. This sewer serves as an outlet for all of the area within the River Des Peres and the Deer Creek watersheds within the City of St. Louis and St. Louis County. It was built in 1914 and, because of the large increase in population and sewage flows in these areas, it is now in need of relief to provide the necessary additional capacity for the ultimate development. The City has had prepared complete detailed construction plans and specifications for this relief sewer construction, which is estimated to cost \$3,500,000. The contracts between the City of St. Louis and the County municipalities and districts using this sanitary sewer for outlet service provides for a pro rata division of the cost to be borne by these County communities on the basis of the ratio of population within each of these communities to the total population of the entire watershed, based upon the most current census population figures. These contracts

provide for a recalculation of connection charges at ten-year intervals based upon the new decade census figures. The County areas, therefore, will have to raise the proportionate cost of the relief sewer work carried out by the City of St. Louis when this construction is undertaken.

Recommended Plans without Sewage Treatment Plants: In general, the plans recommended for the watersheds within the County involve the construction of trunk sanitary sewer facilities in order to provide closed and, in general, gravity systems to carry the sewage to the Mississippi River.

AT PRESENT THERE EXISTS IN ST. LOUIS COUNTY APPROXIMATELY 160 SEWAGE TREATMENT PLANTS OF VARIOUS TYPES RANGING FROM SMALL SEPTIC TANKS TO ACTIVATED SLUDGE PLANTS. IN ADDITION, HUNDREDS OF INDIVIDUAL SEPTIC TANKS NOW SERVE INDIVIDUAL RESIDENCES WHERE COLLECTING SEWERAGE FACILITIES ARE NOT AVAILABLE. IT IS APPARENT THAT UNLESS TRUNK SANITARY SEWERAGE FACILITIES ARE PROVIDED FOR THE GRAVOIS, MALINE-COLDWATER, AND WATKINS CREEKS WATERSHEDS, THAT LOCAL DEVELOPMENTS WITH SMALL TREATMENT PLANTS, USUALLY NOT MAINTAINED, FOR SMALL AREAS WILL CONTINUE TO BE PROVIDED AT AN EXTRAVAGANT TOTAL COST, BUT WITH VERY INSANITARY CONDITIONS REMAINING IN THE WATERSHEDS.

Probable Future Treatment at the Mississippi River: Within the St. Louis metropolitan area, both in the States of Missouri and Illinois, industrial wastes, except for a few instances such as oil refineries or chemical plants and raw sewage carried by the collecting systems of combined and separate sewers is discharged without treatment into the Mississippi River. Health authorities throughout the country have for some time urged the adoption of a policy to establish standards to be enforced by State agencies to prevent

pollution of natural water-courses. In the St. Louis area, even the low water flows of the Mississippi River are of sufficient volume to provide satisfactory dilution of the maximum sewage flows and industrial wastes discharged into the river. However, the State authorities, both in Missouri and Illinois, are insisting that in unsewered areas, all new sewers be dual or separate systems with sanitary sewage flow carried only in sanitary sewers with no connection to the storm water facilities. This matter of pollution of the Mississippi River, we understand, is now being investigated by the Federal and State health agencies as a joint project for the Bi-State Development Agency.

If some form of treatment is finally required, it is assumed that it will not involve more than primary treatment, which may result in approximately 50 per cent purification and consist essentially of settling basins. If this policy prevails, the City of St. Louis will be put to a tremendous cost to construct diluted dry weather flow intercepting sewers on the existing combined systems, and primary treatment plants with the necessary accessories, such as sludge beds and digestors. No estimates of cost are herewith submitted for the work which the City of St. Louis would be required to carry out if primary treatment is ordered. However, in Part I of this report, there has been estimated costs for primary treatment for each of the watershed trunk sanitary sewerage systems. These costs are shown in the detailed report and not repeated in the following summary.

On Fig. 3 of the detailed report there is shown the general plan of the recommended trunk sanitary sewerage facilities required. Preliminary detailed plans and profiles are submitted under the discussion of each of the watersheds. From these preliminary plans and profiles, there have been prepared estimates of cost of construction for the sanitary sewerage facilities recommended, the summary of which is as follows:

SUMMARY TABLE OF COST
OF RECOMMENDED TRUNK SANITARY SEWERAGE FACILITIES
FOR URBANIZED PORTION OF ST. LOUIS COUNTY
AND THE CITY OF ST. LOUIS

Watershed	Est. Cost Trunk San. Sewerage Facilities	Present Population	Current Assessed Valuation
Gravois Creek	\$ 2,610,000	34,000	\$23,000,000
Maline-Coldwater Creeks	4,823,000	83,000	80,000,000
Watkins Creek	129,000	2,400	1,800,000
Watkins Creek Sewage Treatment	550,000		
River Des Peres Tributaries between Gravois and Deer Creeks	112,000	4,700	14,000,000
River Des Peres north and west of University City, in- cluding complete sanitary sewerage system for Wells- ton District	<u>948,000</u>	45,000	36,000,000
Total cost of County Facilities	\$ 9,172,000		
In City of St. Louis, relief of River Des Peres foul water sewer	<u>3,500,000</u>		
Total:	\$12,672,000		
If Wellston Sewer District is served with combined sewers, deduct cost of sani- tary facilities of	<u>650,000</u>		
Total cost, exclusive of Wellston	\$12,022,000		

Section III - Suggested Methods and Agencies for Administering the Construction of the Recommended Sanitary Sewerage Facilities Presented in This Report:

The recommended plan for new construction of trunk sanitary facilities, with the exception of the area within the River Des Peres watershed, involves facilities in watersheds not requiring outlet service through the City of St. Louis sewers. Under the present sewer district law, petitions could be filed with the Circuit Court for the establishment of watershed sanitary sewer districts, each to embrace the entire particular watershed. The present law requires the submission of a petition signed by one hundred property owners to be submitted to the Circuit Court for the establishment of a sewer district. However, under the present law, the limitations of 5 per cent of the assessed valuation would not enable such an overall district to undertake the full construction of the trunk sewers. If this law were amended either to permit the issuance of Sewer Rental Bonds or to allow a debt in the amount of 10 per cent of the assessed valuation, such overall sewer districts could provide the trunk facilities, but with each such district operating separately within its own watershed. The work performed by these districts would, of course, be in accordance with the standards of the State and County health authorities. Some of such districts, however, even with the present law amended to permit a greater debt and the issuance of revenue bonds, would fall short of financing the complete program of trunk sewers, laterals, and possibly primary treatment.

Overall County District: The lower value districts may require aid which might be provided from an overall agency granted the authority to either accumulate funds from a general levy over the entire urban area or the right to present a bond issue to the entire area, funds from which could be used to aid in the construction of sewers in specific areas. This practice would conform

to the policies established in the City of St. Louis where General Bond issues for sewer purposes are voted by the entire community and used on specific projects where the need is greatest. Of course, in the City it is assumed that ultimately adequate sewer facilities will be uniformly provided throughout. Some such suggestion is included in the recommendations made in the report of the committee to the County Court.

St. L. Co.
Metropolitan Sanitary Sewer District: The creation of such an overall agency or district within the County only, could be in the form of a St. Louis County metropolitan sewer district which could undertake the establishment of watershed districts, the presentation of bond issue elections to the voters within such districts, and also the presentation of bond issue elections to the entire district for funds to be used to supplement funds authorized within particular watersheds. Such a district should also be provided with powers to establish tax bill or special assessment districts for the construction of local laterals, with the cost borne entirely by the property within such tax bill districts. This would be similar to the present authority which municipalities have been granted in the State of Missouri for tax bill sewer construction.

Joint City and County Metropolitan Sewer District: As hereinafter described in a discussion of agencies necessary for the construction of storm drainage facilities, the agency, instead of being solely a County district, could be a metropolitan sewer district embracing both the City and the County, and having the administrative duties of planning, constructing, and presenting the financing to the areas for both sanitary and storm facilities, and of maintaining all sewer facilities. Greater efficiency and much lower maintenance cost would result if all maintenance were carried out under one agency.

Under the present sewer district law, the Districts do not have the necessary police power to force the use of the facilities provided and must depend upon County or municipal agencies for such police power. From a practical standpoint, it would appear advisable to create an overall agency to coordinate the work in the various sections in the urban area in St. Louis County; to establish with the cooperation of the health agencies the basic common standards to assure the construction of adequate facilities for ultimate development, and to have the necessary police powers to prevent pollution of natural water-courses which are generally dry runs in the smaller watersheds in St. Louis County.

CONSIDERATION OF THE BI-STATE DEVELOPMENT AGENCY IN THIS PROGRAM
OF PROVIDING ADEQUATE SANITARY SEWERAGE FACILITIES

The present acts of the State Legislatures of Missouri and Illinois specify that the Bi-State Development Agency may plan and establish policies for sewerage and drainage facilities. This agency, therefore, could assist in establishing common basic standards and in planning integrated improvements. If the State Legislatures amend the present act creating the Bi-State Development Agency and grant also the authority to plan, construct, and maintain sewerage and drainage facilities, and if both states specifically empower this agency to finance the construction of such facilities with funds obtained through the sale of revenue bonds, then the Bi-State Development Agency could assist in the construction of the required sanitary sewerage facilities in the following manner: Contracts could be entered into between the sewer districts and the Agency for annual payments equal to the sewer rentals collected by the contracting district. Such contracts could be arranged between the Agency and sewer districts organized under the present sewer law in the County, or between the Agency and watershed districts, or between the Agency and an overall County or metropolitan sewer district. These contracts would require the present sewer district law to be amended to allow the issuance of sewer rental bonds

with the further authority to grant the District the option to contract with other governmental agencies, such as the Bi-State Development Agency, for the construction of sewer facilities on the basis of annual payments equal to the sewer rentals authorized and collected by the individual Districts. Such an arrangement would be of distinct advantage to existing sewer districts operating under the present law or to individual watershed districts, as the attractiveness of the sewer revenue bonds issued by the Bi-State Development Agency would be much greater than if issued by the smaller districts mentioned. A further advantage of such an arrangement in the case of the watershed districts would be that the trunk sanitary sewer construction could be financed by contracting with the Bi-State Development Agency, thereby permitting the individual watershed districts to undertake the construction of the necessary storm water facilities with funds obtained through the issuance of general obligation bonds where authorized by the voters. However, if an overall County, such as a County metropolitan sewer district, or a joint City and County metropolitan sewer district was created and granted the powers of financing the construction of the necessary sanitary sewer facilities, there would be no advantage in dealing with the Bi-State Development Agency as the issues of sewer rental bonds from a metropolitan sewer district would find just as favorable a market as the Bi-State Development Agency.

STORM WATER FACILITIES

Part II presents a discussion of the present storm water facilities, points out their deficiencies, and suggests a master plan of trunk storm water facilities with preliminary estimates of cost for both the City and the County.

On Fig. 1, showing the watersheds within the City and the County, it will be noted that the central area comprising the River Des Peres and Harlem-Baden watersheds embraces both City and County areas.

JOINT CITY AND COUNTY AREAS

Harlem-Baden Watershed: In Part II of this report there is discussed in detail the capacities of the present combined facilities and the necessary relief to provide adequately for the storm water runoff in these watersheds. Preliminary designs and estimates of cost are presented for the additional facilities necessary both within the City and the County. It will be noted that the total estimated cost is \$13,500,000, which includes necessary relief of the present County facilities.

The contracts between the City of St. Louis and the County Sewer Districts provide for connection charges to be paid on the basis of sanitary sewage flow. These contracts further provide that where storm water is carried by County facilities in combined sewers, that the matter of connection charges for increased storm water runoff resulting from developed areas and improved storm water facilities be determined by the courts and that a test suit be filed for such determination. Up to the present time, the courts have not been requested to pass on this matter, so that no connection charges for use of City storm water facilities have been paid to the City by County districts.

The construction of the relief facilities in the Harlem-Baden watersheds, especially in the low areas within the City of St. Louis, is one of extreme

urgency, as flooding of property and sizable damages occur whenever the rainfall exceeds the capacities of the sewers. In these low areas, flooding of basements with damage to various types of electrical equipment, now in common use, is of relatively frequent occurrence. Legal determination of the issues which will indicate the equitable proportioning of the cost of relief sewers in watersheds embracing both City and County areas is necessary, in order to permit the undertaking of the relief in these watersheds. The suggested construction of relief sewers in these watersheds within both the City and County could also be undertaken by a metropolitan sewer district with powers to finance the construction from proceeds obtained through the sale of General Obligation Bonds authorized by the taxpayers.

River Des Peres Watershed: The contemplated sewer program presented by the City of St. Louis contains an item for the improvement of the River Des Peres paved channel and reconstruction of the outlet at the junction with the Mississippi River in the amount of six million dollars. This project and expenditure is also a matter of joint concern between the City and the County areas lying within the River Des Peres, including the Deer Creek watershed, which areas are served by the River Des Peres open channel within the City.

Relief Sewer Projects within the City of St. Louis: There has been made available to us a report prepared by the Department of the President of the Board of Public Service of the City of St. Louis which tabulates the program of additional sewers necessary for relief of existing combined sewers serving only areas within the City of St. Louis. The total estimated cost of such new sewer construction, exclusive of the relief system required in the Harlem-Baden watershed, amounts to 32 million dollars. This information is submitted herewith to indicate the total overall storm water sewer program within both the City of St. Louis and St. Louis County areas.

St. Louis County Storm Water Needs: In Part II of the detailed report there is presented preliminary studies and estimates of cost for improving the natural open channels. The capacities of the channels proposed are based on the development permissible by present zoning and on the runoff occurring on such development from a ten-year frequency rainfall. The plans provide generally for the cutting off of bends and improving the alignment of the creek, deepening and widening of the present natural channels where necessary, in instances improving the capacity of the channel by paving the bottom and sides, and the reconstruction or enlarging of the waterway cross section under such bridges which now create serious bottlenecks and result in backing up of flood flows. The proposed construction generally is that considered as the minimum required to prevent flooding of the developed areas within and adjacent to the valleys of the watersheds as shown on Fig. 1.

Gravois Creek: The improvement of Gravois Creek and principal branches from its junction with the River Des Peres storm water channel of the City of St. Louis as presented in the detailed report is estimated to cost \$3,160,000. In the design of the River Des Peres storm water channel within the City of St. Louis below the junction with Gravois Creek, the runoff from Gravois Creek watershed was included. The estimate of cost herewith presented provides for the contemplated new work required within the County only.

Although in recent years with the present development, excessive rainfall has resulted in flooding of properties along Gravois Creek, the overall improvements suggested are not of immediate concern and should be scheduled at a time when the assessed valuation of the properties within the watershed have materially increased so that financing of the construction of the proposed storm water needs would be possible.

Water-courses Draining the Area Tributary to the River Des Peres between the Gravois and Deer Creek Watersheds: An analysis of the present natural creeks in this area and of the existing bridges carrying highways across these creeks indicates that the only work necessary will involve straightening and widening of the lower reaches of the principal water-courses tributary to the open channel of the River Des Peres in the City of St. Louis. This proposed construction is not of immediate concern as the institutional areas along the lower reaches of the water-courses will not be seriously damaged from overbank overflows resulting from peak rainfalls. When the damages make necessary the proposed improvement, it will require the formation of a storm water district to raise the necessary funds to administer the construction and levy taxes required to pay the interest and retire the bonds issued for this work.

Deer Creek Watershed: The proposed storm water program within the Deer Creek watershed which involves providing adequate capacities for the main Deer Creek and the principal branches is of immediate necessity. Within this valley, the development has reached a point where flooding of properties is of frequent occurrence, resulting in appreciable damages and, in the past, in some loss of life. Individual communities where damages have been large are aware of the need to improve Deer Creek for increased flood flows, but have set it aside because of its regional nature involving a number of municipalities within the watershed. The current assessed valuation of taxable property within this watershed which is over 100 million dollars can provide, within the constitutional limitations now existing, the funds necessary to carry out the proposed improvements required to prevent flooding of the low areas within this watershed.

In addition to the improvement of the main Deer Creek channel and the principal trunks, the lateral creeks tributary to these facilities are also in need of improvement to provide for the increased runoff from the present

development. The local municipalities cannot undertake these improvements until outlet facilities of adequate capacity are provided. DEER CREEK IMPROVEMENTS SHOULD BE SCHEDULED WITHOUT ANY FURTHER DELAY.

Suggested Improvements Along the Principal Stem of the River Des Peres:

Wellston Sewer District: The dense development and large concentration of population within this area has not only resulted in a seriously unsanitary condition, but in excessive damages due to flooding of property from overflows of present channels. The combined sewer facilities as detailed by the Wellston Sewer District estimated to cost approximately two million dollars should be provided as soon as possible. The cost of this project cannot be financed under the present sewer law. The suggested amendments for increase in debt and for revenue bonds would permit the construction of the combined facilities as planned for the Wellston Sewer District. THIS PROJECT IS OF FIRST PRIORITY IN ST. LOUIS COUNTY.

River Des Peres through University City and West of University City:

The estimates presented in Part II of this report for the improvement of the open channel through University City west of Harvard Avenue and west of University City are based upon providing adequate capacities for the runoff from a ten-year frequency rainfall. The City of University City is now having alternate studies made to determine the most economical plan of improvement along this stream and will have detailed construction plans and specifications prepared for the selected plan. West of University City it will be necessary to clear the channel and carry out such improvements so that flood flows will be confined generally within the channel.

The preliminary estimated cost of the improvements along the principal stem of the River Des Peres including the work within University City is \$3,150,000.

Maline Creek: The preliminary plan for the improvement of Maline Creek commencing at the improved channel provided by the City of St. Louis at the city limits involves generally the straightening, deepening and widening of the present water-course to the City of Ferguson. Above Ferguson the natural channel has not been encroached upon and has sufficient capacity if clearing of growth and brush is carried out and satisfactory future maintenance is provided.

The estimate for improving Maline Creek channel, including reconstruction of such bridges which are now bottlenecks including also the improvement of the principal branches is \$1,575,000. If the financing of the required sanitary facilities, which are of greater importance to the valley than the proposed storm facilities, is arranged for by Sewer Rental Bonds - the construction of the storm water facilities as herein suggested could be carried out from funds obtained through the sale of General Obligation Bonds almost within the present constitutional limitations. In recent years flood flows have overtopped the creek banks in and near the City of Ferguson. With continued development in the watershed, flooding of property will become more aggravated and make necessary the carrying out of the improvements suggested.

Watkins Creek: The present creek within this watershed below Bellefontaine Road and the present crossings of highway and railroad structures appear to be adequate for storm water runoff from ten-year frequency rainfalls. It will be necessary, of course, to keep the channel clear of undergrowth and brush and to prevent encroachments on the present channel in order not to reduce the natural channel capacity. No estimate of cost has been presented for the storm water needs of this watershed.

Coldwater Creek: Sometime ago a drainage district was incorporated for Coldwater Creek, new rights-of-way were acquired, and straightening of the channel carried out. The present County Court comprises the Board of Trustees

of this drainage district. As stated in Part II of this report the detailed construction plans for the work carried out by this drainage district are not available, as a search of the County records indicated merely a map of the district showing the benefited properties against which taxes were levied. The Engineer employed by the Trustees for the preparation of construction plans and the supervision of construction carried out is deceased, and it is impossible to obtain copies of the construction plans.

In recent years the City of St. Louis has enclosed practically all of Coldwater Creek channel through the Lambert-St. Louis Municipal Airport. The area within this watershed to the south of Lambert Field has been rapidly developing with a high percentage of impervious surfaces. As a result, flood flows within the upper reaches of this watershed are increasing materially and have resulted in flooding of the airport as well as the property to the south thereof. Some flooding has occurred due to peak flows in and near the City of Florissant.

The preliminary plan of improvement submitted in this report contemplates straightening and paving where the present improvements have encroached upon the valley so that wide unpaved channels of the required capacity are not now feasible. Through the airport property it will ultimately be necessary to construct additional closed storm water facilities to supplement the present box and arch sewers adequate for the ultimate runoff from the area above Lambert Field. This new construction will have to be carried out to a point to the north of the Wabash Railroad right-of-way from which location an adequate open channel involving essentially widening of the present channel will be necessary. In the summary of estimates of cost for storm water facilities there is indicated separately the cost of the work through the City of St. Louis airport.

The scheduling of construction of the storm water facilities in this watershed for the upper reaches above the Wabash Railroad may be necessary within the relatively near future if frequent flooding of Lambert Field is to be avoided.

Summary of Costs for Storm Water Facilities: In the following table there is tabulated the summary of the estimated costs of the storm water facilities ultimately necessary for the urban area of St. Louis County and the City of St. Louis.

ESTIMATED COST OF SUGGESTED STORM WATER FACILITIES

St. Louis County:

<u>Watershed</u>	<u>Estimated Cost</u>
Gravois Creek	\$3,160,000
Principal water-course tributary to River Des Peres between Gravois and Deer Creeks watersheds	50,000
Deer Creek	3,700,000
River Des Peres thru U. City from the end of the closed sewer at Harvard Avenue	3,350,000
Combined sewers for the Wellston Dist.	2,000,000
Maline Creek	1,575,000
Coldwater Creek*	<u>5,000,000</u>
TOTAL: for County Watersheds	\$18,835,000

*Included the estimated cost for the storm water facilities in Coldwater Creek watershed is the enlargement necessary through Lambert Field to provide adequately for the estimated ultimate runoff from the areas tributary to Coldwater Creek upstream from Lambert Field. We understand that the County Court has delegated the jurisdiction to the City of St. Louis through Lambert Field for the Coldwater Creek facilities. The estimated cost of providing the additional capacity through Lambert Field is \$3,000,000.

Estimated Cost of Suggested Storm Water Facilities (continued)

TOTAL: for County Watersheds (brought forward) \$18,835,000

Joint County and City Storm Sewer Needs:

Harlem-Baden	\$13,500,000
Lower River Des Peres	6,000,000

City of St. Louis Combined Relief Sewer Needs:

See City of St. Louis Report of March 15, 1949	\$32,000,000
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Discussion of Agencies for Storm Water Program: Funds for the financing of a storm water sewer program could be obtained either by the sale of General Obligation Bonds authorized by the taxpayers or by special assessments levied against the benefited area in the form of special taxes. Revenue bonds cannot be issued for storm water sewer construction unless the sewers happen to be combined sewers carrying also sanitary sewage (applicable in the County to the Wellston Sewer District only).

If a program of storm water sewer construction is to be undertaken, County Sewer Districts established to include the entire area within watersheds as suggested for the construction of trunk sanitary sewers could be utilized. The existing County sewer districts could not undertake such a program, as practically all of the districts embrace only a small part of the total watershed. Only those of the present districts which are located adjacent to the ridge of the watershed could provide the necessary facilities for their areas. The existing districts along the intermediate reaches or lower portions of the watershed would have to parallel the City of St. Louis practice of providing facilities adequate for the entire area above their boundaries which, under the present constitutional limitations for debt, would not be feasible.

If watershed districts were to undertake the construction of storm water facilities, with the exception of possibly the Deer Creek branch of the River Des Peres, most of the other areas would require more funds for construction than would be available under the present limitation of 5 per cent of the assessed valuation. In certain instances under present conditions of development, even 10 per cent of the assessed valuation would not provide the required cost of the necessary storm water facilities. However, as heretofore, stated, the ultimate facilities for which the preliminary plans and estimates of cost are presented need not be undertaken until further development has resulted in a material increase in the total of taxable property within the watershed.

If a watershed district undertook the construction of both sanitary and storm facilities, it would be necessary in most instances to provide authority to issue Sewer Rental Bonds for the sanitary sewer construction and General Obligations Bonds or tax bills for the entire storm water sewer program. As described in the "Discussion of Agencies for the Construction of Sanitary Sewerage Facilities," it would be desirable to provide an overall agency in the County or a joint City and County agency which could provide the necessary personnel for the policing and maintenance of the storm water facilities.

The Bi-State Development Agency, limited by the act creating this agency to revenue-producing projects, could not function on a storm water sewer construction program. If the Bi-State Development Agency had funds available to assist in planning, such assistance could be very beneficial in aiding watershed sewer districts in planning and starting the program.

In Part II of the detailed report there is mentioned the importance of properly planning the necessary storm water facilities so as not to unduly increase the storm water runoff and make necessary enlargement of existing

downstream facilities within the City of St. Louis. This now particularly applies to the City of St. Louis River Des Peres storm water facilities, which may not need relief if the type of improvements for County storm water facilities within this watershed are properly planned. Such planning can only be obtained by a joint City and County agency such as an overall metropolitan sewer district. Sanitary flows and storm water flooding recognizes no man-made boundaries. Nature has provided water-courses within watersheds which travers more than one municipality. The metropolitan area of St. Louis in Missouri requires an overall agency for this program.

The new Missouri State Constitution provides and specifies the steps necessary to create metropolitan districts for joint functions of the City and County. It is recommended that the County and City authorities consider the problem now existing in the St. Louis metropolitan area in Missouri in order to take such steps as are set out in the State Constitution to present to the people the matter of the creation of a metropolitan sewer district. Similar problems to those described in this area pertaining to both storm and sanitary facilities have been solved in other metropolitan areas by the creation of a metropolitan district or by the establishment of a joint district embracing a number of separate and distinct districts. This matter of providing adequate sanitary facilities to prevent menaces to health as the population increases, and to provide storm facilities to prevent flooding of developed area, requires immediate attention. The present situation cannot be allowed to continue without resulting in an intolerable situation which will require much greater costs to alleviate at a later date.

Respectfully submitted

HORNER & SHIFRIN
Consulting Engineers

PART I

SANITARY SEWERAGE FACILITIES

Section 1 - Introduction: There is herewith presented a survey of present conditions with respect to sanitary sewerage for the recognized urbanized portion of St. Louis County or sections in St. Louis County in which urban development is now becoming paramount. The area covered by this report within St. Louis County extends from and including the Gravois Creek watershed on the south to and including Maline and Watkins Creeks watersheds on the north, with the addition of the Coldwater Creek watershed to the west and north of Maline and Watkins Creeks. This area is roughly described as the area within the County lying between the city limits of St. Louis and a line following Lindbergh Boulevard from its southerly limits to about Highway 66, thence approximately along Geyer and Ballas Roads from Highway 66 and Olive Street Road, thence northwardly along Lindbergh Boulevard from Olive Street Road to Lambert Field, and north of Lambert Field all of St. Louis County except the fringe areas along the Missouri River bluffs. The area above described in St. Louis County is shown on Fig. 1 of this report.

It will be noted from Fig. 1 that the central area, which includes the entire watershed of the River Des Peres and its branches, and the so-called Harlem and Baden watersheds, embrace parts of the City of St. Louis proper in addition to the area in St. Louis County. The watersheds to the north and south of this central area lie entirely within St. Louis County.

To the south of the Gravois Creek watershed between its southerly ridge and the northerly ridge of the Meramec River watershed there lies an area in which extensive development has occurred where the drainage is naturally directly tributary through small watercourses to the Mississippi River. This

area includes Jefferson Barracks and the developments along the boundaries of Jefferson Barracks. The facilities necessary for this area are local in character and involve construction of additional facilities to those now existing which can, in most instances, connect either to the Jefferson Barracks system or discharge directly into the Mississippi River.

Section 2 - Existing Sanitary Facilities by Watersheds (See Fig. 2):

A - Gravois Creek - There does not now exist any coordinated collecting system of sanitary sewers for this entire watershed. The facilities that have been provided, including the public sewers constructed by public agencies, have been built for local needs with no attempt to coordinate the facilities into one comprehensive efficient collecting system. The major facilities and capacities of existing treatment plants provided by municipal organizations within this watershed are shown in Table I-1 and are as follows:

1. A sanitary sewerage and trickling filter sewage treatment plant constructed by Affton Sanitary Sewer District.

2. A privately operated activated sludge sewage treatment plant located on Gravois Creek to the south of Highway 66 constructed and maintained by Russell & Company under agreements with the Trustees of the subdivisions within the southwest portion of the City of Webster Groves and in the area to the south and west of Southwest Webster Sewer District where portions of collecting systems have been constructed to reach this treatment plant.

3. Sanitary sewerage systems within the Village of Oakland and in the Southwest Webster Sewer District, which includes, in addition to the area within the City of Webster Groves, portions of the Village of Crestwood. These systems

carry the sewage to an activated sludge sewage treatment plant maintained by the Village of Oakland and the Southwest Webster Sewer District on the banks of Gravois Creek south of Big Bend Boulevard.

4. The City of Kirkwood has constructed the necessary sanitary sewers for the central, eastern and southern portions of the City with an activated sludge treatment plant located near the southeast corner of the City of Kirkwood, which treatment plant is now being expanded to the capacity as shown in Table I-1 for service to this portion of the City of Kirkwood.

In addition to the above major facilities, there exist, as shown in Table I-1, scattered and local sewers with and without satisfactory treatment plants. These scattered facilities were constructed generally by the subdividers of the properties in order to permit the development and utilization of the property.

Of the present total population of Gravois Creek of about 34,000, sewage treatment facilities in some form exists for a total of approximately 26,000 people, with the type of plant ranging from the modern activated sludge plant of the City of Kirkwood to septic tanks with a capacity to partially treat sewage from a population of 48.

Table I-1 also shows the existing sewers serving present subdivided property which discharge into sink holes which are found in the Gravois Creek watershed. The facilities provided for these subdivisions merely consist of a sanitary sewer collecting the sewage from improved property and discharging into the natural sink holes. In the tabulation showing the present facilities for treatment of sewage, no effort was made to indicate the individual septic tanks which may exist in the Gravois Creek watershed

serving not more than one or two residences. Undoubtedly a number of individual septic tanks are maintained by the individual homes where no collecting system exists, as the St. Louis County Health Department in recent years has required the construction of septic tanks followed with filter beds where no sanitary sewers exist.

B - Facilities in River Des Peres Watershed adjacent to the City Limits
Line of the City of St. Louis between Gravois Creek and Deer Creek Watersheds:

Other than a few villages incorporated by the County Court, no organized municipalities or sewer districts exist in this area, with the exception of a portion of the City of Shrewsbury, which is served by a system of sewers connected to the City of St. Louis River Des Peres Foul Water Sewer. Repeated efforts have been made to incorporate a sewer district designated as the Lakewood Sanitary Sewer District to provide sanitary sewers for the greater portion of this area. However, such efforts failed to receive the approval of the necessary affirmative votes required by law to permit the issuance of bonds. The facilities which exist are local in character and here again also provided by land subdividers interested in furnishing the minimum of sanitary facilities to permit the developments which have taken place. It will be noted in Table I-2 that four treatment plants providing partial treatment have been constructed for subdivisions in this area. The balance of the sanitary sewer facilities consist of gravity sewers, most of which are connected to the River Des Peres Foul Water Sewer of the City of St. Louis. However, instances exist where such sewers discharge into natural sink holes. In the area on the south adjacent to the south line of the Webster Groves Sanitary Sewer District, systems of sanitary sewers have been constructed for the subdivisions within and beyond the City of Webster Groves. However, no satisfactory outlet has been constructed to carry this sewage to the River Des

Peres Foul Water Sewer of the City of St. Louis. At present the sewage from these areas is discharged into a creek at the intersection of Heege Road and the St. Louis & San Francisco Railroad right-of-way. Efforts are now being made to contract with the City of St. Louis for the extension of this sewer so as to provide adequate sanitary outlet sewer facilities for this area, the cost of such construction and contract obligations with the City of St. Louis for connection charges to be borne by the property owners within the area.

The City of St. Louis has constructed and maintains a sanitary sewer along the River Des Peres valley in close proximity with the southern limits of the City which carries the sanitary sewage flow to the Mississippi River. Contracts have been entered into by municipalities and sewer districts for connections to this sewer to permit the discharge of the sanitary sewage from County areas into the City sewer. This sewer was constructed by the City in 1914 and is now inadequate for the sewage flow from the River Des Peres watershed. The City of St. Louis in its 1944 bond issue was authorized to construct a relief sewer, plans for which have been completed, which, with the existing sewer, will provide the necessary capacities for the sewage flow from the ultimate population of the entire watershed.

C - Watershed of the Deer Creek Branch of the River Des Peres: The facilities provided by municipalities and sewer districts for the urban area within the Deer Creek watershed consist of an integrated system of sanitary sewers with the outlet connected to the River Des Peres Foul Water Sewer of the City of St. Louis at the junction of Deer Creek and the River Des Peres. As shown on Fig. 2 and Table I-3, the communities and sewer districts have provided the necessary sanitary facilities to adequately serve the population of the Deer Creek watershed with the exception of the following areas:

A small area lying between the Webster Groves Sanitary Sewer District and the Village of Rock Hill where no sewers exist.

Areas within Two-Mile Creek Sanitary Sewer District, in the northern portion of Kirkwood adjacent to the Two-Mile Creek Sanitary Sewer District and in the Village of Des Peres where lateral sewers will be necessary as the areas develop, the trunk sanitary sewer facilities have been provided.

Areas in the Village of Frontenac between Lindbergh Boulevard and Spode Road to the north of the Two-Mile Creek Sanitary Sewer District, which can contract for outlet service for a system of sanitary sewers within this area with the Ladue-Deer Creek Sanitary Sewer District, whose trunk facilities have been designed adequately for service to this area. It will, of course, also be necessary to contract with the agencies downstream from the Ladue-Deer Creek District for use of downstream facilities to the Mississippi River. The balance of Frontenac to the west of Spode Road and north of the northern boundaries of the Two-Mile Creek District is now served with individual and common septic tanks, and it is expected that this type of sanitary facility will be adequate for Frontenac, as the zoning in this area should be on the order of one acre tracts. If individual septic tanks prove unsatisfactory due to a denser development, the Village of Frontenac should be required to provide a modern treatment plant, the effluent from which would be satisfactory to discharge into Deer Creek. To the north of

Frontenac there has recently been incorporated the Village of Creve Coeur which, except for the southeastern corner, which is included in the Laude-Deer Creek Sanitary Sewer District area, does not contain sanitary sewerage facilities. If this area is to be permitted to develop into a dense urban area, it will be necessary to provide not only an integrated system of sanitary sewers, but also a modern sewage treatment plant, as the downstream facilities are not designed for sewage flow from this area. The present population of the Deer Creek watershed is estimated at about 92,000.

D - The Watershed of the Principal Branch of the River Des Peres North and West of the Deer Creek Watershed: Within the City of St. Louis a sanitary sewer has been constructed along the storm water open channel north and westwardly from the junction with the Deer Creek branch to the vicinity of Macklind and Manchester Avenues. For the balance of the River Des Peres valley, the City of St. Louis has constructed a combined sewer carrying both sewage and storm water runoff from the open channel ending in the vicinity of Macklind and Manchester to the western city limits of St. Louis near Skinker Road north of Delmar Boulevard. Beyond this point the Cities of St. Louis and University City have provided a closed combined sewer to the northern city limits of University City along the branch of the River Des Peres draining the Wellston area. University City has extended the closed sewer along the principal stem of the River Des Peres westwardly from the city limits of St. Louis to the vicinity of Harvard Avenue, a distance of approximately 4,000 feet. Beyond this point in University City, combined sewers with foul water interceptors have been constructed, which interceptors are connected to the foul water sewer in the bed of the River Des Peres to the northwestern limits

of University City. This foul water sewer is inadequate from Harvard Avenue to North & South Road, and from 82nd and Olive Boulevard to the northwestern city limits. University City is now having alternate studies made and plans prepared principally for providing adequate storm water facilities along the principal stem of the River Des Peres from Harvard Avenue westwardly which will cover the deficiencies of the present sanitary sewer. There still exists in the western part of University City undeveloped areas which are not served with sanitary sewer facilities, such facilities are provided by University City as the development of the area requires. It is understood that in those sections where the storm water facilities along the River Des Peres are to be open channels dual systems of sewers will be built with the sanitary sewers only connected to the foul water sewer of the River Des Peres.

In Table I-4 there has been listed for this watershed the existing sewage treatment plants serving more than two families with type of plant and present capacity. The only modern plant which has been constructed in this area is that serving the Village of Bel-Nor, which is an activated sludge plant adequate to provide treatment for a population of 1,500. The total population served by treatment plants is approximately 3,850.

There has also been listed in Table I-4 and shown in Fig. 2 the areas now provided with sanitary sewerage facilities connected to either the University City system or directly to the City of St. Louis. Between Deer Creek and University City the areas within incorporated communities are served by combined sewers which are connected at the city limits of St. Louis with the city sewers. To the north of University City the eastern part of Wellston is also connected directly to the city sewers. The balance of the Wellston area, with the exception of Glen Echo Village along Lucas & Hunt Road and south of Natural Bridge is unsewered except for unrecorded sewers which cannot be considered as adequate.

Under the present laws permitting sewer districts in St. Louis County, there has been incorporated the Wellston Sewer District area and bonds voted in the amount of \$460,000. The proceedings under which this incorporation was authorized by the Circuit Court provided for a combined system of sewers for this area estimated to cost in excess of two million dollars current prices. Plans have been prepared with funds advanced by the Federal Government for the combined system of sewers required in this area. However, as the District cannot finance such construction, no bonds have been issued and no progress is being made toward providing either the necessary sanitary or storm water facilities in the Wellston District.

To the north of University City sanitary sewers have been constructed by the Hanley Page East Sewer District and by the Vinita Terrace Sewer District. Vinita Park has recently voted a bond issue and is engaged in preparation of plans for the construction of the necessary facilities for Vinita Park. The areas within the southern portion of Overland and in the Village of Olivette and the unincorporated areas to the west of Olivette and Overland, with the exception of the facilities shown in Table I-4 are not provided with adequate sanitary sewerage facilities.

Present County populations within areas tributary to River Des Peres, exclusive of Deer Creek watershed, are about 4,700 for the area between Gravois Creek and Deer Creek and 98,600 above Deer Creek Junction.

E - Harlem-Baden Watershed: As shown in Table I-5 and Fig. 2, the area within St. Louis County in the Harlem-Baden watersheds has been provided in general with combined sewer facilities by sewer districts established under the present sewer law pertaining to St. Louis County. Inasmuch as most of this watershed is served with combined sewers, the discussion of the present

facilities in this area is contained in Part II covering existing storm water sewers and requirements. (See Table I-5.)

F - Maline Creek Watershed: In Table I-6 is shown the tabulation of the existing sanitary sewer facilities serving the area in the Maline Creek watershed. The Carsonville Sewer District has partially completed the construction of an activated sludge treatment plant. However, work has stopped before any equipment was installed in the pumping station or settling tanks, so that at present this plant is not functioning and the sewage collected by the sanitary sewerage system discharges directly into Maline Creek at the plant site. The other public plants consist of activated sludge sewage treatment plant of the Walton Road Sanitary Sewer District on the west bank of the Maline Creek a short distance upstream from the Carsonville District treatment plant site, and the Ferguson activated sludge sewage treatment plant serving essentially the City of Ferguson. In addition, there exists nine other treatment plants of various types constructed privately, including the plant constructed by the City of St. Louis at the St. Louis Training School, having a capacity to serve a total population of approximately 18,000, compared to the present total population within the Maline Creek watershed of approximately 41,000. The Normandy Sewer District commenced the construction of sanitary sewers during the Works Progress Administration period, and has completed forty per cent of the system, but no work was done on the contemplated treatment plant on Maline Creek for this District.

It will also be noted from Fig. 2 and Table I-6 that the area adjacent to the city limits of St. Louis within the so-called City Maline Creek Branch has been sewered with the sewers being connected to the City of St. Louis system under contract with the City.

A small portion of the City of Berkley, which is situated to the north of Walton Road and Carsonville Sewer Districts, lies within these Districts. Recently this municipality voted a \$650,000 bond issue, equal to approximately 20 per cent of its assessed valuation, for sewer construction. This community is now planning to provide sewers for the area within the City of Berkley directly tributary to Maline Creek. It is also contemplating contracting for sewer service with the Walton Road Sewer District for that portion of the City which can be served by that District's treatment plant; and for that portion of the area which can be served by the present Carsonville Sewer District, the District and the City of Berkley are contemplating partial completion of the present plant to provide primary treatment only for both the Carsonville District area and for such area in the southeastern portion of Berkley which can be served by such a plant.

The most aggravated condition within the Maline Creek valley exists in the Kinlock Park area where a dense population resides with no recorded sanitary facilities existing to serve such population. Apparently either privies or individual septic tanks are used on small lots with a resultant intolerable condition existing.

Here, as in Gravois Creek watershed, there is no coordinated trunkline sewer system for sanitary sewage flow from the developments within the watershed.

G - Watkins Creek Watershed: This is a small area lying on the west bank of the Mississippi River between the Maline and Goldwater Creeks watersheds. No recorded existing sanitary sewerage facilities have been found in this watershed. Apparently the present developments are served with individual septic tanks only.

H - Spanish Lake Area: To the north of the Watkins Creek area there has been developed along the east side of the C.B. & Q. R.R. and south of Trampe Road a fairly extensive subdivision on the shores of Spanish Lake. This development is served with sanitary sewers and with a septic tank and sand filter for treatment.

I - Coldwater Creek Watershed: As shown on Fig. 2 and Table I-7, sanitary sewer facilities have been provided in a scattered manner for local needs for the portions of the watershed between the source of Coldwater Creek and the City of Florissant. Two modern public treatment plants have been provided in this watershed by the St. Johns-Overland Sanitary Sewer District and the City of St. Ann. Three plants have been constructed for the facilities at Lambert-St. Louis Municipal Airport. A primary settling basin and digester has been provided for the City of Florissant. The balance of the facilities are essentially of private nature for industry or subdivisions and vary in type from a common septic tank to small activated sludge treatment plants. The total present population served by the treatment plant facilities in the Coldwater Creek watershed, including Lambert Field, is approximately 42,000. In addition to these common plants there exists a large number of individual septic tanks serving not more than two homes. The total present population in the Cold Water Creek watershed, exclusive of Lambert Field, is about 40,000.

Here in the Coldwater Creek valley, similar to Gravois and Maline Creeks vallies, there is no integrated coordinated sanitary sewerage system for efficient service to the developments of this watershed.

Section 3 - Brief Summary of Existing Sanitary Sewerage Facilities in Metropolitan St. Louis west of the Mississippi River: From the foregoing description of existing facilities by watersheds, an inspection of Fig. 2 on which is shown the incorporated municipalities and sewer districts and the existing sewerage

facilities provided privately outside of the incorporated cities and communities, and from an inspection of Tables I-1 to I-7, inclusive, showing in detail the existing facilities of record in each watershed, it can be seen that the following general conditions with respect to sanitary sewerage exist.

River Des Peres: Between the eastern watershed lines of the River Des Peres and Harlem-Baden, and the Mississippi River, the entire area lies within the City of St. Louis and is served with combined sewers built by the City of St. Louis which discharge directly into the Mississippi River; no problem regarding sanitary sewerage facilities exists.

Within the River Des Peres, including the Deer Creek watershed, there are included areas lying partly within the City and partly within the County, with the City portion being the downstream part of the watershed. Within the City areas there have been provided combined sewers with the exception of a separate sanitary sewer in the main valley of the River Des Peres where the storm water facilities consist of an open channel. Much of the area immediately contiguous to the western limits of St. Louis is also now served by combined sewers connected directly to the City of St. Louis sewers. These facilities are adequate for sanitary sewerage service with the exception of the River Des Peres foul water sewer of the City of St. Louis, which requires relief and for which plans have been completed. The cost of such construction under the provisions of the contracts between the City of St. Louis and the communities served by the City foul water sewer will have to be borne by the entire area.

The County area tributary to Deer Creek in general is served with adequate sanitary sewers with deficiencies in the upper reaches which require sanitary facilities which can be provided as the development makes necessary, except for the area to the west of Spode Road in the Village of Frontenac and

west of Lindbergh Boulevard in the Village of Creve Coeur which will require local individual or common treatment, depending upon the zoning of the presently undeveloped areas.

For the principal branch of the River Des Peres running westwardly from the St. Louis city limits at University City, the areas now inadequately served with sanitary sewerage facilities are principally the Wellston area, the areas between University City and the Hanley Page District, and the area to the north and west of the Hanley Page District, and the areas to the north and west of University City lying within Overland, Olivette, and the unincorporated areas near the extreme west watershed line of the River Des Peres.

Harlem-Baden Watershed: This watershed embraces area within the City and the County, some of which is presently generally sewered with combined sewers in need of relief for storm water runoff. The sanitary facilities appear to be adequate. Inasmuch as this watershed is served generally by combined sewers, the discussion of needs of this problem is contained in Part II of this report.

Gravois Creek: To the south of the City of St. Louis lies the Gravois Creek watershed entirely within the County. With the exception of the facilities provided in the upper reaches of this watershed and by the Affton Sewer District in the central portion, most of the watershed is still unsewered. This entire area is definitely in need of trunk facilities which can be provided throughout the area with the lateral facilities constructed for the presently developed area as soon as the trunk facilities are available and for the undeveloped area as development occurs. The trunkline facilities of this watershed will have to be carried separately to the Mississippi River, as the City of St. Louis River Des Peres Foul Water Sewer has not been designed for this ultimate sewage flow.

Maline Creek: In this watershed, which is practically entirely within the County, a similar situation exists to that within the Gravois Creek with the bulk of present development existing in the upper reaches of the watershed. No coordination or integrated sanitary sewerage system for the entire watershed now exists, which apparently is the urgent need for this area.

Coldwater Creek Watershed: Here also the development has taken place in the upper reaches where sanitary sewerage facilities and treatment has been provided, with isolated local instances of inadequate treatment existing in the balance of the watershed.

APPROXIMATE POPULATIONS BY WATERSHEDS

Gravois Creek	34,000
River Des Peres between Gravois and Deer Creeks	4,700
Deer Creek	91,700
River Des Peres above Deer Creek Junction	98,500
Harlem Baden	41,700
Maline Creek	41,400
Watkins Creek	2,400
Coldwater Creek	<u>40,400</u>
Total County population in urban area	354,800

Present Treatment Plants: There now exist in the County urban area approximately 160 sewage treatment plants of which 54 have been tabulated by watersheds. Generally all of the others are septic tanks serving two or more residences. In addition to these plants there are probably hundreds of septic tanks serving individual homes. This creates a condition which cannot continue without causing aggravated unsanitary conditions which will seriously retard further continued growth in the County.

TABLE I-1

EXISTING SANITARY SEWERAGE FACILITIES IN GRAVOIS CREEK WATERSHED(a) Plants:

	Location	Type of Plant	Present Capacity Population	Owner
1.	Aftton	Trickling Filter	4,000	Aftton Sanitary Sewer District
2.	Gravois Creek S. of Highway 66	Activated Sludge	1,600	Russell & Company
3.	Oakland	Activated Sludge	3,500	Village of Oakland & South-west Webster S.S.D.
4.	Leffingwell and Short Street	Activated Sludge	15,000	City of Kirkwood
5.	Reavis Barracks Rd. & Ripa Ave.	Activated Sludge ("Pkg." Plt.)	700	Village of St. George
6.	Bayless Ave. & Avenue H	Septic Tank & Sand Filter Imhoff Tank & Sand Filter	72 184	Cardinal Hills Subdivision
7.	W. of Lemay Ferry Rd. on S. Side of Highway 77	Septic Tank	48	Crescent Acres Subdivision
8.	Lemay Ferry Rd. & Green Pk. Rd.	Septic Tank	120	Green Park Hills Subdivision
9.	Lemay Ferry Rd. & Ripa Ave.	Screen chamber, Imhoff Tank, Sludge Beds	252	Lemay Gardens Subdivision
10.	Lemay Ferry Rd. & Telegraph Rd.	2 Septic Tanks	472	Point Breeze Subdivision
11.	Dana Ave. near Forman Rd.	Connects to Aftton Sewer District		Dana Ridge Subdivision
			<hr/>	
			25,948	

(b) Existing Sewer Systems Without Treatment:

Monticello Subdivision (Discharges to sink hole).
Ridgeview Subdivision (Combined sewers discharge to sink hole).
Rose Gardens Subdivision (Discharges to sink hole).
Belle Villa, City of (Discharges to sink holes).
Grasso Ave. Subdivision (Discharges to sink hole).
Lakeshire, Village of (Discharges to sink holes).

TABLE I-2

EXISTING SANITARY SEWERAGE FACILITIES IN RIVER DES PERES WATERSHED
BETWEEN GRAVOIS CREEK WATERSHED AND DEER CREEK WATERSHED

(a) Plants:

	Location	Type of Plant	Present Capacity		Owner
			Population		
1.	In Proposed Lakewood S.S.D.	Septic Tank and Underground Filter Bed	100		Ashwell Place Subdivision
2.	Mackenzie and Heege Rds.	Septic Tank and Sand Filters	500		Heege View Subdivision
3.	Mackenzie and Heege Rds.	4 Septic Tanks	544		Heege Hills Subdivision
4.	In Proposed Lakewood S.S.D.	Septic Tank and Sand Filter	100		Staley Avenue Subdivision
			1,244		

(b) Existing Sewer Systems Without Treatment:

St. Louis, City of (Foul water sewer along open channel; combined sewers elsewhere).

Wilbur Park, Village of (Connects to City of St. Louis sewers)

St. Louis County Sewer District No. 1 (Connects to City of St. Louis sewers).

Area along southeast side of Gravois Rd. adjacent to City Limits of St. Louis.

Area between north line of proposed Lakewood S.S.D. and Gravois Creek Watershed and south line of Webster Groves S.S.D., including portions of City of Webster Groves and the Village of Marlborough.

Mackenzie Village (Connects to City of St. Louis sewers).

Shrewsbury, City of (Eastern part connects to City of St. Louis sewers).

TABLE I-3

EXISTING SANITARY SEWERAGE FACILITIES IN DEER CREEK WATERSHED

EXISTING SEWER SYSTEMS WITHOUT TREATMENT

Webster Groves Sanitary Sewer District (Trunk outlet connected to City of St. Louis Sewer).

Maplewood, City of (Connected to Richmond Heights trunk, and thence to Webster Groves Sanitary Sewer District trunk).

Brentwood, City of (Connected to outlet sewer of Ladue-Deer Creek Sanitary Sewer District).

Richmond Heights, City of (Connected to Webster Groves Sanitary Sewer District trunk).

Clayton, City of)	
	)	(Connected to Richmond Heights trunk)
Clayton Outfall Sewer District)	

McKnight Village Sanitary Sewer District (Connected to Richmond Heights trunk).

University City, Southwest Corner of (Connected to McKnight Village Sanitary Sewer District).

Olivette, City of, Southern Part of (In Ladue-Deer Creek Sanitary Sewer District).

Rock Hill Village (Connected to outlet trunk of Ladue-Deer Creek Sanitary Sewer District).

Glendale, City of (Connected to outlet trunk of Ladue-Deer Creek Sanitary Sewer District).

Ladue, City of (In Ladue-Deer Creek Sanitary Sewer District).

Ladue-Deer Creek Sanitary Sewer District (Connected to Webster Groves Sanitary Sewer District outlet).

Two-Mile Creek Sanitary Sewer District (Connected to Ladue-Deer Creek Sanitary Sewer District).

Kirkwood, City of, Northeast Part of)	
)	
Warson Woods, Village of)	
)	
Huntleigh, Village of)	
	)	(In Two-Mile Creek Sanitary Sewer District)
Crystal Lake Park, Village of)	
)	
Frontenac, Village of, Southern Part of)	

EXISTING SANITARY SEWERAGE FACILITIES IN RIVER DES PERES WATERSHED
NORTH AND WEST OF DEER CREEK WATERSHED

(a) Plants:

Location	Type of Plant	Present Capacity Population	Owner
1. St. Charles Rock Rd. E. of Carson Rd.	Activated Sludge	1,500	Village of Bel-Nor
2. Page Av. abt 3/4 mi. W. of N. & S. Rd.	Septic Tank	68	Crystal Court Subdivision
3. Page Av. abt 1/4 mi. W. of N. & S. Rd.	Septic Tank and Sand Filters	36	Crystal Court 1st Addn. Subdivision
4. E. Side Normandy Rd. N. of Wellston Hills	Septic Tank	340	Greendale Subdivision
5. Olive St. Rd. W. of Woodson	Imhoff Tank	136	Hilltop Woods Subdivision
6. Lackland and Midland	Imhoff Tank and Sand Filters	120	Lake Sherwood Subdivision
7. E. Side Brown Rd., S. of Flora	Temporary Septic Tank	196	Stratford Terrace Subd.
8. Lackland Rd., Bryant to Northfield	Septic Tank and Sand Filters	364	Victoria Park Subdivision
9. Normandy Rd. and St. Charles Rock Rd.	Septic Tank	1,088	Wellston Hills Subdivision
		<u>3,848</u>	

(b) Existing Sanitary Sewer Systems Without Treatment:

St. Louis, City of (Combined sewers).

University City (Combined sewers and foul water sewer along open channel; connects to City of St. Louis sewers).

Glen Echo Park, Village of

Hanley-Page East Sanitary Sewer District (Includes part of Villages of Pagedale and Hanley Hills. Connects to University City sewers).

Vinita Terrace Sanitary Sewer District.

South Lackland Sanitary Sewer District (Pumped over ridge into St. Johns - Overland Sanitary Sewer District).

Eastern part of City of Wellston (Connects to City of St. Louis sewers).

Eastern part of City of Maplewood (Connects to City of St. Louis sewers).

Eastern part of City of Richmond Heights (Connects to City of St. Louis sewers).

Eastern part of City of Clayton (Connects to City of St. Louis sewers).

TABLE I-5

EXISTING SANITARY SEWERAGE FACILITIES IN HARLEM-BADEN WATERSHED

EXISTING SEWER SYSTEMS WITHOUT TREATMENT

Curtis Sewer District (Combined sewers connected to City of St. Louis sewers).

Maria Creek Sewer District (Combined sewers connected to City of St. Louis sewers).

Pinelawn Sewer District (Combined sewers connected to City of St. Louis sewers).

Melrose Sewer District (Combined sewers in eastern part connected to City of St. Louis sewers). (Separate sanitary sewers in western part, ultimately connected to City of St. Louis sewers).

Jennings - West Walnut Manor Sewer District (Combined and separate sanitary sewers connected to City of St. Louis sewers).

TABLE I-6

Sheet 1 of 2

EXISTING SANITARY SEWERAGE FACILITIES IN MALINE CREEK WATERSHED(a) Plants:

Location		Type of Plant	Present Cap city Population	Owner
1.*	Springdale Ave. N. of Natural Br.	Activated Sludge		Carsonville S.S.D.
2.	Ferguson	Activated Sludge	7,500	Ferguson S.S.D.
3.	Oakborough Subdivision	Activated Sludge	2,000	Trustees of Subdivision
4.	St. Louis Training School	Activated Sludge	660	State of Missouri
5.	Springdale Ave. N. of Natural Br. Rd.	Activated Sludge	6,500	Walton Road S.S.D.
6.	Chambers Rd. to Crown Point	Imhoff Tank and Trickling Filter	400	Atwater Terrace Subdivision
7.	City of Berkeley	Imhoff Tank, Sand Filter and Dry. Bed	224	Bangert Place Subdivision
8.	Chambers Rd. and Dorothy Ave.	Septic Tank and Sand Filter	132	Coburg Ridge No. 2 Sub-division
9.	Chambers Rd. and Dorothy Ave.	Screen Chamber, Imhoff Tank	140	Coburg Lands Subdivision
10.	City of Jennings	Lift Sta., Septic Tank and Sand Filter	168	Forest Hills Terrace Subdivision
11.	Bellefontaine and Chambers Rd.	2 Septic Tanks	180	Green Acres Subdivision
12.	Kinloch Park	Septic Tank and Sand Filters	80	Veterans Housing Project
*Plant incomplete and not operating. Designed for 4,000 pop.			17,984	

(b) Existing Sewer Systems Without Treatment:

Carsonville Sanitary Sewer District (80% sewer, discharges into Maline Creek).

Normandy Sanitary Sewer District (40% sewer, discharges into Maline Creek).

Area between City Limits of St. Louis and south ridge line of Maline Creek
(Connected to City of St. Louis sewers).

East Riverview Gardens Sanitary Sewer District (Partly sewer with connection to City of St. Louis sewers).

TABLE I-7

Sheet 1 of 2

EXISTING SANITARY SEWERAGE FACILITIES IN COLDWATER CREEK WATERSHED(a) Plants:

Location	Type of Plant	Present Capacity Population	Owner
1. Brown Rd. and Airport Rd.	Activated Sludge - "Package" Plant	884	Brownleigh Subdivision
2. Florissant	Primary Sed., Digester	2,500	City of Florissant
3. Hazelwood	Activated Sludge	3,342	Ford Motor Co.
4. Lambert-St. Louis Airport	Activated Sludge	10,000	McDonnell Aircraft Corp.
5. Lambert-St. Louis Airport	Activated Sludge	3,000	U.S. Naval Reserve Air Station
6. Lambert-St. Louis Airport	Imhoff Tank and Trickling Filter	500	U.S. Naval Reserve Air Station
7. N. of St. Charles Rock Rd. on Coldwater Creek	Activated Sludge	12,000	St. Johns - Overland S.S.D.
8. St. Ann	2 Pkts. New Activ. Sl. Plant Imh. Tk. Fil. & Dry Bed	3,320 3,200	City of St. Ann
9. Highway 77, $\frac{1}{4}$ mile N. of Natural Bridge	Septic Tank	200	Airport View Subdivision
10. City of Berkeley	Imhoff Tank, Sand Filter and Drying Bed	100	Belvoir Place
11. Air Lane	Septic Tank and Underground Filter Bed	68	Bridgeport Subdivision
12. Bridgeton Terrace	Septic Tank and Sand Filter	640	Village of Bridgeton Terrace

TABLE I-7(Cont.)

Sheet 2 of 2

Location	Type of Plant	Present Capacity Population	Owner
13. Ashby Rd. and Breckenridge Rd.	Lift Sta., Septic Tank and Sand Filters	1,208	Buder Park Subdivision
14. Natural Bridge and Edmundson Rds.	Lift Sta., Septic Tank and Filter Bed	600	Village of Edmundson
15. Brown Rd., $\frac{1}{2}$ mi. E. of Hwy. 77	Septic Tank and Sand Filter	100	Lloyd A. Fry Roofing Co.
16. Brown Rd., $\frac{1}{2}$ mi. E. of Hwy. 77	Septic Tank and Sand Filter	150	General Motors Corp., Elec- tromotive Div.
17. On Coldwater Cr. N. of Wabash R.R.	Septic Tank	500	Robertson Mechanical School
18. On Graham Rd. in Berkeley	Septic Tank and Sand Filters	96	Wickham Park Subdivision
		<u>42,408</u>	

Suggested New Sanitary Sewerage Facilities: In view of the present conditions there is herewith submitted as part of this report a detailed analysis of the needs of the St. Louis Metropolitan Area for sanitary sewerage service to provide adequately for the continued orderly development of the County and for the preservation of public health throughout the area.

Section 4 - Basis of Design for Sanitary Sewers: The design of sanitary sewers requires a knowledge of the population expected to be served by the facilities. To determine these populations in the future, estimates have been made based upon existing zoning provisions as formulated by the St. Louis County Planning Commission and Incorporated Communities. These zoning assumptions are predicated upon square footage per lot, and the following indicates the assumed populations related to each of the minimum sized lots permitted by the zoning requirements:

<u>Sq. Ft. Per Lot</u>	<u>No. of Lots per Acre</u>	<u>Persons per Lot</u>	<u>Population per Acre</u>
5,000	7	4	28*
6,000	6	4	24**
7,500	5.5	4	22
20,000	2	5	10
43,560	1	6	6

*This same density has been assumed for "Heavy Industrial zoning.

**For "Light Industrial" and "Commercial" a density of 24 persons per acre has been used.

Each watershed was divided into a number of sub-areas chosen from the available topography on the quadrangles of the Missouri State and United States Geological Survey. All cemetery acreage has been excluded from consideration for sanitary sewerage. The gross area in each of the sub-areas has then been reduced by 20 per cent to allow for roads and streets. To this

net acreage then there has been applied the appropriate figure for the population per acre corresponding to the zoning requirement.

The populations resulting from the above have been further reduced by multiplying by the factor 0.65, which is an experience factor developed in studies by Horner & Shifrin of the population in the River Des Peres watershed made in connection with designs for a trunk sanitary relief sewer in the main River Des Peres valley through the City of St. Louis. In other words, it was found that, in reality, only about 65 per cent of the theoretically attainable population actually materializes.

Under these assumptions it is recognized that the overall ultimate population for any major watershed is conservatively high. It is impossible to predict where ultimate development will specifically occur and sanitary trunk and sub-trunk sewers are properly designed to reflect the possibility that the particular area served may actually achieve the modified ultimate population as above determined.

Design tables were set up for each of the trunks and sub-trunks and the sub-areas collected in proper sequence with the acreage and population accumulating as the table progresses downstream.

To obtain stationing and to develop profiles for preliminary designs and estimates, there have been used the topographic sheets made in the early 1930's under the sponsorship of the City of St. Louis. These sheets cover all of the City and the County east of Lindbergh Boulevard, on a scale of 200 feet to the inch with a five-foot contour intervals; beyond this area, profile data was obtained from U.S.G.S. quadrangles.

To the assumed ultimate populations tributary to the various reaches of the proposed trunk sanitary sewers, there was applied the per capita per day figure of 400 gallons (which equals .00062 cfs per capita per day). For

SUMMARY TABLE OF ESTIMATED COST
OF RECOMMENDED PLAN OF SANITARY SEWERS
FOR URBANIZED AREA OF ST. LOUIS COUNTY, MO.

Watershed	Cost of Trunk & Sub-Trunk San. Sewers	Cost of Lateral Sewers for Ul- timate Develop.	Est. Cost of Primary Treat- ment Plants Along Banks of Miss. River	Est. Cost of Treatment Plant for Ul- timate Pop.	Current Assessed Valuation	Estimated Present Population
Gravois Creek	\$2,610,000	\$3,000,000	\$1,320,000	--	\$23,000,000	34,000
River Des Peres Between Gravois and Deer Creek	112,000	425,000	--	--	14,000,000	4,700
River Des Peres Above Deer Creek Junction	948,000*	1,075,000	--	--	36,000,000	98,500
Maline Creek)	4,823,000	3,500,000	2,250,000	--	30,000,000	41,400
Coldwater Creek)		3,250,000		--	50,000,000	40,400
Watkins Creek	129,000	700,000	--	\$550,000	1,800,000	2,400

*Includes complete system of sanitary sewers for Wellston Sewer District area.

TABLE I-8

SANITARY SEWERS
GRAVOIS CREEK WATERSHED

No.	Area	A C R E A G E		
		Sewered	Unsewered	Total
1.	Affton Sanitary Sewer District	630	0	630
2.	Village of Lakeshire	60	0	60
3.	Bella Villa	60	0	60
4.	St. George	50	0	50
5.	Grantwood Village	0	170	170
6.	Village of Oakland & S.W. Webster S.D.	950	0	950
7.	Crestwood			
8.	Webster Groves (served by Russell & Co. Treatment Plant)	250		250
9.	Sewered Subdivisions:			
	Monticello	20		20
	Ridgeview	30		30
	Rose Garden	25		25
	Green Park	10		10
	Point Breeze	30		30
	Lemay Gardens	15		15
	Cardinal Hill	10		10
	Grasso	5		5
	Dana (Conn. to Affton S.D. Tr. Plt.)	15		15
	Cordes Drive	10		10
10.	City of Kirkwood	1,250		1,250
		3,420	170	3,590
	Total of Gravois Creek Watershed	3,420	10,080	13,500
	Unsewered Acreage Est. to ultimately require sewers		6,000	
	* Est. Cost of Master Plan Sanitary Sewers			
	Gravois Creek Trunk		\$2,400,000	
	Gravois Creek Sub-Trunks		210,000	
	Gravois Creek Laterals		3,000,000	

* Sewage Treatment Plants by-passed.

TABLE I-9

SANITARY SEWERS
RIVER DES PERES WATERSHED
BETWEEN GRAVOIS CREEK AND DEER CREEK

No.	Area	A C R E A G E		
		Sewered	Unsewered	Total
1.	Wilbur Park	35		35
2.	Area along S.E. side Gravois Road adjacent to City Limits of St.Louis (St.L. County S.D. No. 1 & other sewers ult. trib. to City of St. L. South Gravois No. 4 sewers)	130	0	130
3.	Proposed Lakewood Sewer District	0	570	570
4.	Area between N. line of Prop. Lakewood S.D. & Gravois Cr. Watershed and S.L. Webster Groves S.D., which includes portions of Marlborough and City of Webster Groves	150	780	930
5.	Webster Groves San. District (S.portion) (trunk sewers)			
6.	Mackenzie Village - sewerred			
7.	City of Webster Groves			
8.	Shrewsbury - sewerred			
9.	Unsewered area betw. Mo. Pac. & city limits of St.L. west of Gravois Cr.		50	
Total Unsewered Areas			1,400	
Unsewered Acreage Est. to ultimately require sewers			850	
Est. Cost of Master Plan Sanitary Sewers				
Prop. Lakewood Dist. Trunk			\$ 24,000	
Marlborough Trunk			68,000	
Laterals			425,000	
Conn. Charge to City of St.L.(initial payment)			20,000	

TABLE I-10
SANITARY SEWERS
RIVER DES PERES WATERSHED
WEST & NORTH OF UNIVERSITY CITY

No.	Area	A C R E A G E		
		Sewered	Unsewered	Total
1.	Wellston Sewer Dist. (no recognized sewer system)		1,350	1,350
	City of Wellston (sewered only in eastern portion in area directly trib. to City of St. Louis sewers)			
	Pagedale - (no recognized sewers)		140	140
	Glen Echo Park (served by sanitary sewers without satisfactory outlet)			
2.	Hanley-Page East S.D. (completely sewerred)			
	Pagedale (completely sewerred within S.D.)			
	Hanley Hills " " " "			
3.	Vinita Terrace (sewerred)			
4.	Vinita Park (no recognized sewers)		435	435
5.	Bel-Mor (completely sewerred to Tr. Plt. on St. Charles Rock Rd.)			
6.	Olivette		650	650
7.	Overland		896	896
	S. Lackland S.D.	342		342
8.	Unincorp. areas unsewerred N & W of Olivette & Overland		615	
9.	Unincorp. areas N of Univ. City E of N & S Road:			
	Wheaton Area		215	
	Normandy C.C. & Area to E on both sides			
	St. Charles Rock Rd.		140	
	Area along Ferguson Ave.		10	
10.	Sewerred Subdivisions	26		
Total Unsewerred Area			4,451	
Unsewerred areas est. to ultimately require sewers			3,100	
Est. Cost of Master Plan Sanitary Sewers				Cost
	Wellston S.D. area, incl. Conn. charges	950		\$ 650,000
	Bal. of unsewerred areas incorp. communities:			
	Olivette	455		\$ 227,500
	Overland	630		315,000
	Vinita Park	305		152,500
	Pagedale	100		50,000
	Bal. of unsewerred area within unincorp. areas	660		330,000
				<u>\$1,075,000</u>
	Trunk sewer above University City and Woodson Road sub-trunk			\$ 133,000
	Connection charges for use of University City and City of St. Louis sewers, estimated			\$ 165,000

TABLE I-11

SANITARY SEWERS
WATKINS CREEK WATERSHED

No.	Area	A C R E A G E		
		Sewered	Unsewered	Total
1.	Watkins Creek Watershed		2,360	2,360
	Small portion of NE corner City of Bellefontaine Neighbors			
	Unsewered areas est. to ultimately require sewers		1,400	
	Est. Cost of Master Plan Sanitary Sewers			
	Trunk			\$129,000
	Treatment Plant: complete treatment for			
	17,000 pop.		550,000	
	Laterals		700,000	

TABLE I-12
SANITARY SEWERS
MALINE - COLDWATER SYSTEM

No.	Area	A C R E A G E		
		Sewered	Unsewered	Total
<u>MALINE CREEK WATERSHED</u>				
1.	Village of Riverview Gardens(part in other watershed)			
2.	City of Bellefontaine Neighbors (part in other watershed)			
3.	City of Jennings(part in other watershed)	17		
4.	City of Ferguson(entirely in watershed)			
5.	Ferguson Sewer Dist. (entirely in City of Ferguson but not same boundaries)	1,000		
6.	Village of Calverton Park (part in other watershed)			
7.	City of Berkeley (\$650,000 voted for sewerage system & treatment)	1,090		
8.	Carsonville Sewer District	700		
9.	Village of Bel Ridge (99% in S.D.)			
10.	Margona Village (entirely in S.D.)			
11.	City of Berkeley (small part in S.D.)			
12.	Walton Road Sewer District	900		
13.	City of Berkeley (small part in S.D.)			
14.	Village of St. John(part in S.D.)			
15.	City of Overland (part in S.D.)			
16.	Village of Charlack "			
17.	Village of Sycamore Hills "			
18.	Normandy Sewer District(40% sewered no treatment)	260	400	660
19.	Village of Bellerive (entirely in S.D.)			
20.	Town of Normandy (part in S.D.)			
21.	Village of Bel-Nor - sewered with lift station to treatment plant	60	0	60
22.	Sewered Subdivisions:			
	S. of Summit & E. of Mary in Jennings	17		17
	Coburg Ridge No. 2	7		7
	Sheldon Park	17		17
	Green Acres	27		27
	N. Side Chambers, Balboa to Clearview Drive	29		29
23.	City of St. Louis Training School	310		310
	Totals of Maline Creek Watershed	4,434	11,801	16,235
	Unsewered Maline Creek acreage estimated to ultimately require sewers		7,000	

TABLE I-12 (Cont.)

Page 2 of 2
A C R E A G E

No.	Area	Sewered	Unsewered	Total
<u>COLDWATER CREEK WATERSHED</u>				
24.	City of Florissant(entirely in watershed)	1,400	300	1,700
25.	Village of Calverton Park (partly in Maline watershed)			
26.	City of Berkeley (partly in Maline wtrshed) (\$650,000 bond issue voted)	220		1,720
27.	Village of Hazelwood (entirely in watershed)	100	1,790	
28.	Lambert-St. Louis Municipal Airport and Naval Air Station	1,500		1,500
29.	Town of Bridgeton	0		
30.	Village of Bridgeton Terrace	36	0	36
31.	Village of Edmundson	58	0	58
32.	City of St. Ann	472		472
33.	Village of Mary Ridge			55
34.	Village of Woodson Terrace			67
35.	St.Johns-Overland Sewer District - sewers and treatment plant	1,737		1,737
36.	Village of Scheurman Hgts.(entirely in S.D.)			
37.	Elmdale Village "			
38.	Village of St. John (part in S.D.)			
39.	Village of Breckenridge Hills (part in S.D.)			
40.	City of Overland (part in S.D.)			
41.	Sewered Subdivisions:			
	Buder Park	36		36
	Air Lane Road	4		4
Totals of Coldwater Creek Watershed to and including Florissant				
		5,563	10,827	16,390
Unsewered Coldwater Creek acreage estimated to ultimately require sewers				
			6,500	
Est. Cost of Maline-Coldwater Master Plan Sanitary Sewers:				
	Maline-Coldwater Trunk below Ardmore Ave.		\$ 2,200,000	
	Maline-Coldwater Trunk above Ardmore Ave.(incl. lift sta. at Natural Bridge Rd.)		1,403,000	
	Coldwater Lower Trunk (Florissant to Airport), Florissant Lift Sta. & Force Main		751,000	
	Coldwater Creek Sub-Trunks		116,000	
	Maline Creek Trunk above Ardmore Ave.		68,000	
	Maline Creek Sub-Trunks (excluding Ardmore Brch.)		285,000	
Total Costs Maline-Coldwater Trunks, Sub-Trunks, Lift Stations and Force Main				
			\$ 4,823,000	
Maline Creek Laterals				
			3,500,000	
Coldwater Creek Laterals				
			3,250,000	

TABLE I-13

COST ESTIMATE OF PRELIMINARY DESIGN
OF GRAVOIS CREEK SANITARY TRUNK TO MISSISSIPPI RIVER
ALTERNATE 1-G
(No Treatment)

No.	Description	Unit	Quantity	Unit Cost	Total Cost
1.	Class "A" Rock Excavation	cu.yd.	20,000	\$15.00	\$300,000.00
2.	Class "B" Earth Excavation	cu.yd.	185,000	2.00	370,000.00
3.	72" Sewer in Place	lin.ft.	7,400	40.00	296,000.00
4.	66" Sewer in Place	lin.ft.	6,900	34.00	234,600.00
5.	54" Sewer in Place	lin.ft.	8,850	22.50	199,125.00
6.	48" Sewer in Place	lin.ft.	12,750	18.00	229,500.00
7.	42" Sewer in Place	lin.ft.	7,000	13.00	91,000.00
8.	39" Sewer in Place	lin.ft.	3,200	12.00	38,400.00
9.	36" Sewer in Place	lin.ft.	7,400	10.00	74,000.00
10.	30" Sewer in Place	lin.ft.	700	8.00	5,600.00
11.	24" Sewer in Place	lin.ft.	7,000	5.50	38,500.00
12.	21" Sewer in Place	lin.ft.	2,400	4.50	10,800.00
13.	Manholes on 72", Av. Depth 15'	manhole	8	250.00	2,000.00
14.	Manholes on 66", Av. Depth 10'	manhole	7	200.00	1,400.00
15.	Manholes on 54", Av. Depth 16'	manhole	10	250.00	2,500.00
16.	Manholes on 48", Av. Depth 11'	manhole	16	250.00	4,000.00
17.	Manholes on 42", Av. Depth 6'	manhole	13	200.00	2,600.00
18.	Manholes on 39", Av. Depth 12'	manhole	6	225.00	1,350.00
19.	Manholes on 21" to 36", Av. Depth 9'	manhole	35	250.00	8,750.00
20.	Class B Concrete for Bedding and Cradling	cu.yd.	6,000	20.00	120,000.00
21.	Lumber Left in Trench	M.ft.B.M.	50	75.00	3,750.00
22.	Stubs and Junctions	fitting	200	10.00	2,000.00
23.	Outlet Structure at Missis- sippi River	Lump	Sum		15,000.00
					\$2,050,875.00
Contingencies, including Engi- neering, Inspection, etc.					299,125.00
					\$2,350,000.00
Right-of-Way.					25,000.00
					\$2,375,000.00
SAY.					\$2,400,000.00

TABLE I-14

COST ESTIMATE OF PRELIMINARY DESIGN
OF GRAVOIS CREEK TRUNK SANITARY SEWER
ALTERNATE 2-G
OMITTING TREATED SEWAGE

(Kirkwood-Leffingwell, Oakland and Affton
Treatment Plants, Russell & Company)

No.	Description	Unit	Quantity	Unit Price	Total Cost
1.	Class "A" Excavation	cu.yd.	15,000	\$15.00	\$225,000.00
2.	Class "B" Excavation	cu.yd.	135,000	2.00	270,000.00
3.	60" Sewer	lin.ft.	7,400	27.50	203,500.00
4.	54" Sewer	lin.ft.	6,900	22.50	155,250.00
5.	48" Sewer	lin.ft.	3,700	18.00	66,600.00
6.	45" Sewer	lin.ft.	5,150	16.00	82,400.00
7.	42" Sewer	lin.ft.	9,550	13.00	124,150.00
8.	39" Sewer	lin.ft.	3,200	12.00	38,400.00
9.	33" Sewer	lin.ft.	5,300	9.00	47,700.00
10.	30" Sewer	lin.ft.	1,700	8.00	13,600.00
11.	27" Sewer	lin.ft.	3,200	6.50	20,800.00
12.	24" Sewer	lin.ft.	1,600	5.50	8,800.00
13.	21" Sewer	lin.ft.	4,200	4.50	18,900.00
14.	18" Sewer	lin.ft.	1,630	3.25	5,297.50
15.	Manholes on 60" Sewer, Av. Depth 12.5'	manhole	7	250.00	1,750.00
16.	Manholes on 54" Sewer, Av. Depth 12'	manhole	6	250.00	1,500.00
17.	Manholes on 48" Sewer, Av. Depth 16.7'	manhole	3	250.00	750.00
18.	Manholes on 45" Sewer, Av. Depth 12'	manhole	6	250.00	1,500.00
19.	Manholes on 42" Sewer, Av. Depth 13.5'	manhole	12	250.00	3,000.00
20.	Manholes on 39" Sewer, Av. Depth 11.5'	manhole	6	225.00	1,350.00
21.	Manholes on 33" to 18" Sewer, Av. Depth 10.5'	manhole	41	250.00	10,250.00
22.	Class B Concrete for Bedding and Cradling	cu.yd.	4,000	20.00	80,000.00
23.	Lumber Left in Trench	M.ft.B.M.	35	75.00	2,625.00
24.	Stubs and Junctions	fitting	150	10.00	1,500.00
25.	Outlet Structure at Mississippi River			Lump Sum	12,500.00
					<u>\$1,397,122.50</u>
Contingencies, including Engineer- ing, Inspection, etc.					202,877.50
					<u>\$1,600,000.00</u>
Right-of-Way.					20,000.00
					<u>\$1,620,000.00</u>

TABLE I-15

COST ESTIMATE OF PRELIMINARY DESIGN
OF GRAVOIS CREEK SUB-TRUNKS
ALTERNATE 1-G

No.	Description	Unit	Quantity	Unit Cost	Total Cost
1.	Class "A" Excavation - Rock	cu.yd.	2,000	\$15.00	\$ 30,000.00
2.	Class "A" Excavation - Earth	cu.yd.	20,000	2.00	40,000.00
3.	21" Sewer, Complete in Place	lin.ft.	1,400	4.50	6,300.00
4.	18" Sewer, Complete in Place	lin.ft.	8,000	3.25	26,000.00
5.	15" Sewer, Complete in Place	lin.ft.	12,600	2.25	28,350.00
6.	12" Sewer, Complete in Place	lin.ft.	9,000	1.75	15,750.00
7.	Manholes, Av. Depth 9'	manhole	83	240.00	19,920.00
8.	Stubs and Junctions	fitting	200	5.00	1,000.00
9.	Class B Concrete	cu.yd.	500	20.00	10,000.00
10.	Lumber Left in Trench	M.ft.B.M.	10	75.00	750.00
					<u>\$178,070.00</u>
Contingencies, including Engineer- ing, Inspection, etc.					26,930.00
					<u>\$205,000.00</u>
Right-of-Way.					5,000.00
					<u>\$210,000.00</u>

GRAVOIS CREEK SUB-TRUNKS
ALTERNATE 2-G

1.	Class "A" Excavation	cu.yd.	1,500	\$15.00	\$ 22,500.00
2.	Class "B" Excavation	cu.yd.	15,500	2.00	31,000.00
3.	18" Sewer	lin.ft.	3,500	3.25	11,375.00
4.	15" Sewer	lin.ft.	10,500	2.25	23,625.00
5.	12" Sewer	lin.ft.	9,000	1.75	15,750.00
6.	Manholes	manhole	60	240.00	14,400.00
7.	Stubs and Junctions	fitting	125	5.00	625.00
8.	Class B Concrete	cu.yd.	375	20.00	7,500.00
9.	Lumber Left in Trench	M.ft.B.M.	7.5	75.00	562.50
					<u>\$127,337.50</u>
Contingencies, including Engineer- ing, Inspection, etc.					19,662.50
					<u>\$147,000.00</u>
Right-of-Way.					3,000.00
					<u>\$150,000.00</u>

TABLE I-16

COST ESTIMATE OF PRELIMINARY DESIGN
OF S.S. PETER & PAUL CEMETERY (MARLBOROUGH) SANITARY TRUNK

No.	Description	Unit	Quantity	Unit Cost	Total Cost
1.	Class A Excavation	cu.yd.	800	\$15.00	\$ 12,000.00
2.	Class B Excavation	cu.yd.	7,200	2.00	14,400.00
3.	18" Sewer	lin.ft.	3,000	3.25	9,750.00
4.	15" Sewer	lin.ft.	5,520	2.25	12,420.00
5.	Manholes, Av. Depth 10.5'	manhole	25	250.00	6,250.00
6.	Class B Concrete	cu.yd.	75	20.00	1,500.00
7.	Lumber Left in Trench	M.ft.B.M.	5	75.00	375.00
8.	Stubs and Junctions	fitting	50	10.00	500.00
					<u>\$ 57,195.00</u>
Contingencies, including Engineer- ing, Inspection, etc.					8,805.00
					<u>\$ 66,000.00</u>
Right-of-Way.					2,000.00
					<u>\$ 68,000.00</u>

LAKEWOOD DISTRICT BRANCH

1.	Class A Excavation	cu.yd.	300	\$15.00	\$ 4,500.00
2.	Class B Excavation	cu.yd.	2,600	2.00	5,200.00
3.	15" Sewer	lin.ft.	1,900	2.25	4,275.00
4.	12" Sewer	lin.ft.	1,300	1.75	2,275.00
5.	Manholes, Av. Depth 9.8'	manhole	9	250.00	2,250.00
6.	Class B Concrete	cu.yd.	25	20.00	500.00
7.	Lumber Left in Trench	M.ft.B.M.	3	75.00	225.00
8.	Stubs and Junctions	fitting	20	10.00	200.00
					<u>\$19,425.00</u>
Contingencies, including Engineer- ing, Inspection, etc.					2,575.00
					<u>\$22,000.00</u>
Right-of-Way.					2,000.00
					<u>\$24,000.00</u>

TABLE I-17

COST ESTIMATE OF PRELIMINARY DESIGN
OF UPPER RIVER DES PERES TRUNK SANITARY SEWERS (ABOVE UNIVERSITY CITY)
(INCLUDING SOUTH LACKLAND SEWER DISTRICT)

No.	Description	Unit	Quantity	Unit Cost	Total Cost
1.	Class "A" Excavation	cu.yd.	900	\$15.00	\$ 13,500.00
2.	Class "B" Excavation	cu.yd.	16,600	2.00	33,200.00
3.	24" Sewer	lin.ft.	1,450	5.50	7,975.00
4.	18" Sewer	lin.ft.	7,900	3.25	25,675.00
5.	15" Sewer	lin.ft.	2,300	2.25	5,175.00
6.	12" Sewer	lin.ft.	6,050	1.75	10,587.50
7.	Manholes, Av. Depth 10.6'	manhole	47	250.00	11,750.00
8.	Class B Concrete	cu.yd.	100	20.00	2,000.00
9.	Lumber Left in Trench	M.ft.B.M.	8	75.00	600.00
10.	Stubs and Junctions	fitting	100	10.00	1,000.00
					\$111,462.50
Contingencies, including Engineer- ing, Inspection, etc.					16,537.50
					\$128,000.00
Right-of-way.					5,000.00
					\$133,000.00

UPPER RIVER DES PERES TRUNK SANITARY SEWERS (ABOVE UNIVERSITY CITY)
(EXCLUDING SOUTH LACKLAND SEWER DISTRICT - INCLUDING WOODSON RD. SUB-TRUNK)

1.	Class "A" Excavation	cu.yd.	500	\$15.00	\$ 7,500.00
2.	Class "B" Excavation	cu.yd.	10,200	2.00	20,400.00
3.	24" Sewer	lin.ft.	1,450	5.50	7,975.00
4.	18" Sewer	lin.ft.	6,350	3.25	20,637.50
5.	15" Sewer	lin.ft.	3,850	2.25	8,662.50
6.	Manholes, Av. Depth 9'	manhole	32	225.00	7,200.00
7.	Class B Concrete	cu.yd.	50	20.00	1,000.00
8.	Lumber Left in Trench	M.ft.B.M.	5	75.00	375.00
9.	Stubs and Junctions	fitting	75	10.00	750.00
					\$ 74,500.00
Contingencies, including Engineer- ing, Inspection, etc.					11,500.00
					\$ 86,000.00
Right-of-way.					3,000.00
					\$89,000.00

TABLE I-18

COST ESTIMATE OF PRELIMINARY DESIGN
OF MAINE-COLDWATER TRUNKLINE SANITARY SEWER
BELOW ARDMORE AVENUE

(No Sewage Treated)

No.	Description	Unit	Quantity	Unit Cost	Total Cost
1.	Class "A" Excavation	cu.yd.	12,000	\$15.00	\$180,000.00
2.	Class "B" Excavation	cu.yd.	218,000	2.00	436,000.00
3.	78" Sewer	lin.ft.	3,910	48.00	187,680.00
4.	72" Sewer	lin.ft.	8,850	40.00	354,000.00
5.	66" Sewer	lin.ft.	9,221	34.00	313,514.00
6.	60" Sewer	lin.ft.	4,979	27.50	136,922.50
7.	54" Sewer	lin.ft.	7,500	22.50	168,750.00
8.	48" Sewer	lin.ft.	1,865	18.00	33,570.00
9.	Manholes on 78" Sewer, Av. Depth 16'	manhole	4	250.00	1,000.00
10.	Manholes on 72" Sewer, Av. Depth 14'	manhole	9	250.00	2,250.00
11.	Manholes on 66" Sewer, Av. Depth 16.2'	manhole	11	250.00	2,750.00
12.	Manholes on 60" Sewer, Av. Depth 14.7'	manhole	6	250.00	1,500.00
13.	Manholes on 54" Sewer, Av. Depth 18.1'	manhole	8	250.00	2,000.00
14.	Manholes on 48" Sewer, Av. Depth 21'	manhole	2	275.00	550.00
15.	Class B Concrete	cu.yd.	3,000	20.00	60,000.00
16.	Lumber Ordered Left in Place	M.ft.B.M.	25	75.00	1,875.00
17.	Stubs and Junctions	fitting	100	10.00	1,000.00
18.	Outlet Structure			Lump Sum	15,000.00
					\$1,898,361.50
Contingencies, including Engineer- ing, Inspection, etc.					285,638.50
					\$2,184,000.00
Right-of-Way					16,000.00
					\$2,200,000.00

TABLE I-19

COST ESTIMATE OF PRELIMINARY DESIGN
OF COLDWATER-MALINE MAIN TRUNK
(Above Maline Creek at Ardmore Avenue)

No.	Description	Unit	Quantity	Unit Cost	Total Cost
1.	Class "A" Excavation	cu.yd.	3,000	\$15.00	\$ 45,000.00
2.	Class "B" Excavation	cu.yd.	62,000	2.00	124,000.00
3.	54" R.C.P. or 5.0' H.S. in Tunnel	lin.ft.	9,800	50.00	490,000.00
4.	54" Sewer	lin.ft.	7,150	22.50	160,875.00
5.	48" Sewer	lin.ft.	9,550	18.00	171,900.00
6.	36" Sewer	lin.ft.	4,210	10.00	42,100.00
7.	27" Sewer	lin.ft.	3,550	6.50	23,075.00
8.	24" Sewer	lin.ft.	1,310	5.50	7,205.00
9.	Permanent Tunnel Shaft, 47' Av. Depth	each	4	5,000.00	20,000.00
10.	Manholes on 54" Sewer, 12.1' Av. Depth	manhole	8	250.00	2,000.00
11.	Manholes on 48" Sewer, 8.2' Av. Depth	manhole	10	200.00	2,000.00
12.	Manholes on 36" Sewer, 8.4' Av. Depth	manhole	8)		
13.	Manholes on 27" Sewer, 8.6' Av. Depth	manhole	7)	200.00	3,600.00
14.	Manholes on 24" Sewer, 4.7' Av. Depth	manhole	3)		
15.	Class B Concrete	cu.yd.	2,000	20.00	40,000.00
16.	Lumber Left in Trench	M.ft.B.M.	20	75.00	1,500.00
17.	Stubs and Junctions	fitting	100	10.00	1,000.00
18.	Lift Station			Lump Sum	77,000.00
					\$1,211,225.00
Contingencies, including Engineer- ing, Inspection, etc.					181,775.00
					\$1,393,000.00
Right-of-way.					10,000.00
					\$1,403,000.00

TABLE I-20

COST ESTIMATE OF PRELIMINARY DESIGN
OF MAIN TRUNK ABOVE ARDMORE

(No Sewage Treated)

Quantities represent difference between original estimate
for entire trunk and trunk below Ardmore.

No.	Description	Unit	Quantity	Unit Cost	Total Cost
1.	Class "A" Excavation	cu.yd.	500	\$15.00	\$ 7,500.00
2.	Class "B" Excavation	cu.yd.	7,000	2.00	14,000.00
3.	27" Sewer	lin.ft.	1,594	6.50	10,361.00
4.	24" Sewer	lin.ft.	1,091	5.50	6,000.50
5.	18" Sewer	lin.ft.	2,750	3.25	8,937.50
6.	Manholes, Av. Depth 16.5'	manhole	16	300.00	4,800.00
7.	Class B Concrete for Bedding & Cradling	cu.yd.	300	20.00	6,000.00
8.	Lumber Left in Trench	M.ft.B.M.	2	75.00	150.00
9.	Stubs and Junctions	fitting	15	10.00	150.00
					\$ 57,899.00
Contingencies, including Engineer- ing, Inspection, etc.					9,101.00
					\$ 67,000.00
Right-of-Way.					1,000.00
					\$ 68,000.00

TABLE I-21

COST ESTIMATE OF PRELIMINARY DESIGN
OF MALINE CREEK SUB-TRUNKS

(Omitting Ardmore Sub-Trunk)

No.	Description	Unit	Quantity	Unit Cost	Total Cost
1.	Class "A" Excavation	cu.yd.	1,700	\$15.00	\$ 25,500.00
2.	Class "B" Excavation	cu.yd.	33,300	2.00	66,600.00
3.	30" Sewer	lin.ft.	2,800	8.00	22,400.00
4.	27" Sewer	lin.ft.	2,400	6.50	15,600.00
5.	21" Sewer	lin.ft.	7,900	4.50	35,550.00
6.	18" Sewer	lin.ft.	8,600	3.25	27,950.00
7.	15" Sewer	lin.ft.	9,430	2.25	21,217.50
8.	12" Sewer	lin.ft.	1,750	1.75	3,062.50
9.	Manholes, Av. Depth 9.5'	manhole	74	225.00	16,650.00
10.	Stubs and Junctions	fitting	185	5.00	925.00
11.	Class B Concrete	cu.yd.	450	20.00	9,000.00
12.	Lumber Left in Trench	M.ft.B.M.	10	75.00	750.00
					<u>\$245,205.00</u>
Contingencies, including Engineer- ing, Inspection, etc.					<u>36,795.00</u>
					<u>\$282,000.00</u>
Right-of-Way.					<u>3,000.00</u>
					<u>\$285,000.00</u>

TABLE I-22

COST ESTIMATE OF PRELIMINARY DESIGN
OF COLDWATER LOWER MAIN TRUNK

No.	Description	Unit	Quantity	Unit Cost	Total Cost
1.	Class "A" Excavation	cu.yd.	2,000	\$15.00	\$ 30,000.00
2.	Class "B" Excavation	cu.yd.	32,000	2.00	64,000.00
3.	33" Sewer	lin.ft.	4,500	9.00	40,500.00
4.	30" Sewer	lin.ft.	6,500	8.00	52,000.00
5.	27" Sewer	lin.ft.	2,800	6.50	18,200.00
6.	21" Sewer	lin.ft.	1,300	4.50	5,850.00
7.	18" Sewer	lin.ft.	4,100	3.25	13,325.00
8.	Manholes on 33" Sewer, 17.6' Av. Depth	manhole	10)		
9.	Manholes on 30" Sewer, 12.7' Av. Depth	manhole	13)		
10.	Manholes on 27" Sewer, 8.7' Av. Depth	manhole	6)	225.00	9,900.00
11.	Manholes on 21" Sewer, 7.7' Av. Depth	manhole	4)		
12.	Manholes on 18" Sewer, 10.4' Av. Depth	manhole	11)		
13.	Class B Concrete	cu.yd.	500	20.00	10,000.00
14.	Lumber Left in Trench	M.ft.B.W.	20	75.00	1,500.00
15.	Stubs and Junctions	fitting	100	10.00	1,000.00
16.	Force Main - 30" Diameter	lin.ft.	18,000	16.00	288,000.00
17.	Pump Station			Lump Sum	114,000.00
					\$648,275.00
	Contingencies, including Engineer- ing, Inspection, etc.				97,725.00
					\$746,000.00
	Right-of-Way.				5,000.00
					\$751,000.00

TABLE I-23

COST ESTIMATE OF PRELIMINARY DESIGN
OF COLDWATER CREEK SUB-TRUNKS
ALTERNATE 1

(No Sewage Treated)

No.	Description	Unit	Quantity	Unit Cost	Total Cost
1.	Class "A" Excavation	cu.yd.	800	\$15.00	\$ 12,000.00
2.	Class "B" Excavation	cu.yd.	15,300	2.00	30,600.00
3.	21" Sewer	lin.ft.	1,420	4.50	6,390.00
4.	18" Sewer	lin.ft.	3,780	3.25	12,285.00
5.	15" Sewer	lin.ft.	10,480	2.25	23,580.00
6.	Manholes, Av. Depth 9.4'	manhole	45	250.00	11,250.00
7.	Class B Concrete	cu.yd.	80	20.00	1,600.00
8.	Lumber Left in Place	M.ft.B.M.	5	75.00	375.00
9.	Stubs and Junctions	fitting	100	10.00	1,000.00
					\$ 99,080.00
Contingencies, including Engineer- ing, Inspection, etc.					14,920.00
					<u>\$114,000.00</u>
Right-of-Way.					2,000.00
					<u>\$116,000.00</u>

COLDWATER CREEK SUB-TRUNKS
ALTERNATE 2
(Sewage Treated)

1.	Class "A" Excavation	cu.yd.	1,200	\$15.00	\$ 18,000.00
2.	Class "B" Excavation	cu.yd.	21,100	2.00	42,200.00
3.	24" Sewer	lin.ft.	6,500	5.50	35,750.00
4.	21" Sewer	lin.ft.	1,420	4.50	6,390.00
5.	18" Sewer	lin.ft.	4,180	3.25	13,585.00
6.	15" Sewer	lin.ft.	12,430	2.25	27,967.50
7.	Manholes, Av. Depth 8.5'	manhole	71	250.00	17,750.00
8.	Class B Concrete	cu.yd.	100	20.00	2,000.00
9.	Lumber Left in Place	M.ft.B.M.	8	75.00	600.00
10.	Stubs and Junctions	fitting	150	10.00	1,500.00
					\$165,742.50
Contingencies, including Engineer- ing, Inspection, etc.					25,257.50
					<u>\$191,000.00</u>
Right-of-Way.					4,000.00
					<u>\$195,000.00</u>

TABLE I-24

COST ESTIMATE OF PRELIMINARY DESIGN
OF COLDWATER CREEK MAIN TRUNK
ALTERNATE 2

(Sewage Treated)

No.	Description	Unit	Quantity	Unit Cost	Total Cost
1.	Class "A" Excavation	cu.yd.	5,000	\$15.00	\$ 75,000.00
2.	Class "B" Excavation	cu.yd.	84,000	2.00	168,000.00
3.	54" Sewer	lin.ft.	4,500	22.50	101,250.00
4.	48" Sewer	lin.ft.	1,500	18.00	27,000.00
5.	45" Sewer	lin.ft.	7,800	16.00	124,800.00
6.	42" Sewer	lin.ft.	2,250	13.00	29,250.00
7.	36" Sewer	lin.ft.	12,900	10.00	129,000.00
8.	27" Sewer	lin.ft.	2,680	6.50	17,420.00
9.	24" Sewer	lin.ft.	1,530	5.50	8,415.00
10.	18" Sewer	lin.ft.	3,550	3.25	11,537.50
11.	Manholes on 54" Sewer, Av. Depth 16.3'	manhole	6	250.00	1,500.00
12.	Manholes on 48" Sewer, Av. Depth 15'	manhole	2	250.00	500.00
13.	Manholes on 45" Sewer, Av. Depth 7.4'	manhole	9	200.00	1,800.00
14.	Manholes on 42" Sewer, Av. Depth 6.4'	manhole	5	200.00	1,000.00
15.	Manholes on 36" Sewer, Av. Depth 7.6'	manhole	27)		
16.	Manholes on 27" Sewer, Av. Depth 8.7'	manhole	6)		
17.	Manholes on 24" Sewer, Av. Depth 12.3'	manhole	3)	250.00	11,250.00
18.	Manholes on 18" Sewer, Av. Depth 8'	manhole	9)		
19.	Concrete, Class B	cu.yd.	1,200	20.00	24,000.00
20.	Lumber Left in Trench	M.ft.B.M.	20	75.00	1,500.00
21.	Stubs and Junctions	fitting	150	10.00	1,500.00
20.	Lift Station at Natural Bridge Road		Lump	Sum	40,000.00
					<u>\$774,722.50</u>
Contingencies, including Engineer- ing, Inspection, etc.					<u>116,277.50</u>
					<u>\$891,000.00</u>
Right-of-Way.					<u>10,000.00</u>
					<u>\$901,000.00</u>

TABLE I-25

COST ESTIMATE OF PRELIMINARY DESIGN
OF MALINE CREEK TRUNK SANITARY SEWER
(Incl. Sub-Trunk to Carsonville Sewer District Trunk)
ALTERNATE 1-M

(No Sewage Treated)

No.	Description	Unit	Quantity	Unit Cost	Total Cost
1.	Class "A" Excavation	cu.yd.	7,500	\$15.00	\$112,500.00
2.	Class "B" Excavation	cu.yd.	140,000	2.00	280,000.00
3.	60" Sewer	lin.ft.	3,905	27.50	107,337.50
4.	54" Sewer	lin.ft.	8,850	22.50	199,125.00
5.	48" Sewer	lin.ft.	4,300	18.00	77,400.00
6.	45" Sewer	lin.ft.	6,400	16.00	102,400.00
7.	42" Sewer	lin.ft.	1,600	13.00	20,800.00
8.	36" Sewer	lin.ft.	3,715	10.00	37,150.00
9.	30" Sewer	lin.ft.	7,350	8.00	58,800.00
10.	27" Sewer	lin.ft.	1,594	6.50	10,361.00
11.	24" Sewer	lin.ft.	1,091	5.50	6,000.50
12.	18" Sewer	lin.ft.	2,750	3.25	8,937.50
13.	Manholes on 60" Sewer, Av. Depth 14'	manhole	4	250.00	1,000.00
14.	Manholes on 54" Sewer, Av. Depth 13.6'	manhole	9	225.00	2,025.00
15.	Manholes on 48" Sewer, Av. Depth 16.4'	manhole	5	250.00	1,250.00
16.	Manholes on 45" Sewer, Av. Depth 12.8'	manhole	8	250.00	2,000.00
17.	Manholes on 42" Sewer, Av. Depth 12'	manhole	2	250.00	500.00
18.	Manholes on 36" to 18" Sewer, Av. Depth 14.9'	manhole	37	300.00	11,100.00
19.	Class B Concrete for Bedding and Cradling	cu.yd.	4,000	20.00	80,000.00
20.	Lumber Left in Trench	M.ft.B.M.	25	75.00	1,875.00
21.	Stubs and Junctions	fitting	150	10.00	1,500.00
22.	Outlet Structure	Lump Sum			12,500.00
					\$1,134,611.50
Contingencies, including Engineer- ing, Inspection, etc.					169,388.50
					\$1,304,000.00
Right-of-Way.					16,000.00
					\$1,320,000.00

TABLE I-26

COST ESTIMATE OF PRELIMINARY DESIGN
OF MALINE CREEK TRUNK SANITARY SEWER
(Incl. Sub-Trunk to Carsonville Sewer District Trunk)
ALTERNATE 2-M

(Omitting Treated Sewage)

No.	Description	Unit	Quantity	Unit Cost	Total Cost
1.	Class "A" Excavation (Rock)	cu.yd.	6,100	\$15.00	\$ 91,500.00
2.	Class "B" Excavation (Other Than Rock)	cu.yd.	124,200	2.00	248,400.00
3.	60" Sewer	lin.ft.	3,905	27.50	107,387.50
4.	48" Sewer	lin.ft.	8,850	18.00	159,300.00
5.	42" Sewer	lin.ft.	4,300	13.00	55,900.00
6.	39" Sewer	lin.ft.	4,921	12.00	59,052.00
7.	36" Sewer	lin.ft.	3,279	10.00	32,790.00
8.	33" Sewer	lin.ft.	3,715	9.00	33,435.00
9.	27" Sewer	lin.ft.	985	6.50	6,402.50
10.	24" Sewer	lin.ft.	6,365	5.50	35,007.50
11.	21" Sewer	lin.ft.	1,594	4.50	7,173.00
12.	18" Sewer	lin.ft.	1,300	3.25	4,225.00
13.	Manholes on 60" Sewer, Av. Depth 17.3'	manhole	4	275.00	1,100.00
14.	Manholes on 48" Sewer, Av. Depth 14.2'	manhole	9	250.00	2,250.00
15.	Manholes on 42" Sewer, Av. Depth 18.4'	manhole	5	250.00	1,250.00
16.	Manholes on 39" Sewer, Av. Depth 13.6'	manhole	13	250.00	3,250.00
17.	Manholes on 36" to 21" Sewer, Av. Depth 18.4'	manhole	42	325.00	13,650.00
18.	Class B Concrete	cu.yd.	3,500	20.00	70,000.00
19.	Lumber Left in Trench	M.ft.B.M.	30	75.00	2,250.00
20.	Stubs and Junctions	fitting	160	10.00	1,600.00
21.	Outlet Structure	Lump	Sum		12,500.00
					\$948,422.50
Contingencies, including Engineer- ing, Inspection, etc.					142,577.50
					\$1,091,000.00
Right-of-Way.					14,000.00
					\$1,105,000.00

TABLE I-27

COST ESTIMATE OF PRELIMINARY DESIGN
OF MALINE CREEK TRUNK SANITARY SEWER SUB-TRUNKS
ALTERNATE 1-M

(No Treatment)

No.	Description	Unit	Quantity	Unit Cost	Total Cost
1.	Class "A" Excavation	cu.yd.	2,000	\$15.00	\$ 30,000.00
2.	Class "B" Excavation	cu.yd.	36,000	2.00	72,000.00
3.	30" Sewer	lin.ft.	2,800	8.00	22,400.00
4.	27" Sewer	lin.ft.	2,400	6.50	15,600.00
5.	21" Sewer	lin.ft.	7,900	4.50	35,550.00
6.	18" Sewer	lin.ft.	8,600	3.25	27,950.00
7.	15" Sewer	lin.ft.	11,600	2.25	26,100.00
8.	12" Sewer	lin.ft.	1,750	1.75	3,062.50
9.	Manholes, Av. Depth 10'	manhole	80	225.00	18,000.00
10.	Stubs and Junctions	fitting	200	5.00	1,000.00
11.	Class B Concrete	cu.yd.	500	20.00	10,000.00
12.	Lumber Left in Trench	M.ft.B.M.	10	75.00	750.00
					<hr/>
					\$262,412.50
Contingencies, including Engineer-					
ing, Inspection, etc.					<hr/>
					39,587.50
					<hr/>
					\$302,000.00
Right-of-Way.					<hr/>
					4,000.00
					<hr/>
					\$306,000.00

TABLE I-28

COST ESTIMATE OF PRELIMINARY DESIGN
OF WATKINS CREEK TRUNKLINE SANITARY SEWER

No.	Description	Unit	Quantity	Unit Cost	Total Cost
1.	Class "A" Excavation	cu.yd.	650	\$15.00	\$ 9,750.00
2.	Class "B" Excavation	cu.yd.	12,000	2.00	24,000.00
3.	21" Sewer	lin.ft.	8,000	4.50	36,000.00
4.	18" Sewer	lin.ft.	7,000	3.25	22,750.00
5.	Manholes, Av. Depth 7.1' $\frac{1}{2}$	manhole	38	225.00	8,550.00
6.	Class B Concrete for Bed- ding and Cradling	cu.yd.	65	20.00	1,300.00
7.	Lumber Ordered Left in Trench	M.ft.B.M.	4	75.00	300.00
8.	Stubs and Junctions	fitting	80	10.00	800.00
9.	Outlet Structure			Lump Sum	<u>5,000.00</u>
					\$108,450.00
	Contingencies, including Engineer- ing, Inspection, etc.				<u>16,550.00</u>
					\$125,000.00
	Right-of-Way.				<u>4,000.00</u>
					\$129,000.00

preliminary design purposes, this figure is satisfactory and includes allowance for infiltration of ground water through the joints as well as some recognition of the fact that occasional yard drains and downspouts are connected to sanitary sewers even though legally prohibited. In the absence of record data, the State Board of Health has permitted the use of a similar per capita figure for designing trunk sanitary sewers.

It is found necessary in choosing pipe sizes for the various flow quantities developed in the design tables, to assume coefficients of roughness for the interior of the pipes. In accordance with current engineering practice, a Manning "n" of .012 has been used for all sewers 48 inches and larger in diameter. For those sewers less than 48 inches in diameter an "n" of .013 has been used. Because of the preliminary character of these studies, no attempt has been made in the designs to evaluate the so-called minor losses, such as those which occur in manholes, through junctions, on bends, or changes in direction, etc.

All hydraulic gradients were assumed to operate against the water surface in the Mississippi River when the stage is 25.0 at Market Street. This is the criterion used by the City of St. Louis sewer design section for all outlets into the river. The Corps of Engineers "Slope Profiles for Construction Work" dated February, 1949 were used to determine water surface elevations.

In the determination of sewage treatment plant design capacities, the ultimate population to be served has been multiplied by 100 gallons per capita per day. This is the usual practice in evaluating the required size of a treatment plant in preliminary designs, particularly where existing records are not available to suggest any other figure.

Sub-trunks have been designed and estimated between the main trunk sanitary sewer and a point in the tributary stream where the sanitary flow

would approximate 3 cfs. This criterion means that for tributary areas with ultimate populations of less than about 5,000 persons, the required sanitary collecting system will all be considered to be laterals.

Where zoning requires development on the basis of one acre or more per family, no sanitary collecting system is considered necessary. In such cases septic tanks and filter beds for each dwelling were assumed satisfactory.

Section 5 - Studies of Suggested Sanitary Facilities by Watersheds:

A - Gravois Creek Watershed: Two schemes for giving the Gravois Creek watershed complete sanitary sewerage service have been studied.

Alternate 1-G: A system of trunks and sub-trunks has been designed from the Mississippi River to the upper reaches of the Gravois Creek watershed with all existing treatment plants bypassed and the sewage flow carried by gravity to the Mississippi River. The plan for this system is shown on Fig. 3 and the profiles for the trunk on Fig. 4, and sub-trunks on Fig. 5. In the following is set out a brief description of the alignment of the sanitary sewerage system designated as 1-G for the Gravois Creek watershed.

1. The principal trunk sewer generally along the Gravois Creek bottom from the Mississippi River to the lower part of the influent line immediately above the Kirkwood sewage treatment plant, with a by-pass connection at the Russell & Company plant south of Highway 66.

2. A sub-trunk from the proposed Gravois Creek trunk to the sewer line above the Affton treatment plant.

3. A sub-trunk commencing at the Gravois Creek trunk and running along the valley to Buckley Road, designated at the Buckley Road sub-trunk, to serve the area in the southeast portion of the watershed.

4. A sub-trunk, designated as Green Park Road, to serve the area in the south central portion of the Gravois Creek watershed.

5. A sub-trunk, designated as the Sappington trunk, to serve the area along the southwestern portion of the Gravois Creek watershed.

6. A sub-trunk in the central western portion of the Gravois Creek watershed to serve most of the Meecham Park to the south of Kirkwood, designated as Mulberry Creek sub-trunk.

7. A sub-trunk to intercept the outlet sewer above the activated sludge treatment plant maintained by the Village of Oakland and the Southwest Webster Sewer District.

Detailed estimates of cost of construction based upon current prices were prepared from quantities taken off the profiles for trunks and sub-trunks shown on Figs. 4 and 5.

The breakdown estimate for Plan 1-G for the suggested Gravois Creek system is submitted in Table I-13 for the trunk sewer and Table I-15 for the sub-trunks forming the collecting system. The summary of costs for Plan 1-G, which is the recommended plan for Gravois Creek watershed, is submitted in Table I-8. It will be noted that in this summary estimate there has been included an item for Gravois Creek laterals in addition to the principal trunk and sub-trunks. The manner of arriving at the estimate of cost for lateral sewers is described in Section 6 of this report.

Alternate 2-G: This plan differs from Alternate 1-G in that the sanitary sewerage collecting system for Gravois Creek under this plan retains the present public treatment plants and provides the collecting sewers for the sanitary flows for the areas in the watershed not served by the four public treatment plants, plus the additional estimated cost of increasing the treatment plants retained to the capacities necessary for estimated ultimate population. The profiles for the trunk and sub-trunks under Alternate 2-G are shown on Figs. 5 and 6. It will be noted that for this alternate the principal trunk along the Gravois Creek valley has been designed from a point below Watson Road (Highway 66) to the Mississippi River on the assumption that the Russell & Company plant will be expanded and collecting sewers will be constructed to serve all of the area upstream from Highway 66.

Expansion of the present treatment plants under Plan 2-G to provide adequate service for the estimated ultimate population used in the design of the trunk sewers under Alternate Plan 1-G and the estimated costs for such increased capacity is shown in the following tabulation:

EXPANSION OF PRESENT SEWAGE TREATMENT PLANTS

<u>Plant</u>	<u>Present Des. Pop.</u>	<u>Ultimate Des. Pop.</u>	<u>Increase in Pop.</u>	<u>Per Capita Cost</u>	<u>Additional Cost</u>
*Kirkwood	15,000	22,500	7,500	\$25.00	\$187,500.00
*Oakland	2,000	10,000	8,000	30.00	240,000.00
*Russell & Co.	1,600	13,000	11,400	30.00	342,000.00
**Affton	4,000	8,000	4,000	25.00	100,000.00
				Total	\$869,500.00

*Activated sludge treatment plants.

**Trickling filter treatment plants.

The detailed estimate of cost of constructing the principal trunk in Gravois Creek in Alternate Plan 2-G is shown in Table I-14, the total cost including estimated cost for right-of-way being \$1,620,000. The detailed estimate of cost for the sub-trunks under Alternate Plan 2-G totals \$150,000 and is shown in Table I-15.

Discussion of Alternate Plans 1-G and 2-G: It will be noted that the total costs for the trunk, sub-trunks, and for expanding the present sewage treatment plants under Alternate Plan 2-G aggregate \$2,639,500, which is a small amount in excess of the total cost of Alternate 1-G of \$2,610,000. Since the cost for laterals required in the presently unsewered areas would be the same for either alternate, Alternate 1-G is the less costly scheme. This is true from a consideration of capital costs only, and when to this the probable operating charges for the treatment plants are added, Alternate 1-G appears even more favorable.

Probable Future Treatment: Assuming that at some indeterminate future time some treatment of all sanitary sewage will be required before discharge into the Mississippi River, no doubt primary treatment involving screening, sedimentation, sludge digestion will be the highest type of treatment required.

The estimated ultimate population in the entire watershed is 165,000 which will require a primary treatment plant with a capacity of 16.5 mgd which is estimated to cost about \$1,320,000. If the four existing sewage treatment plants with a capacity for 22,600 population, would be expanded to a capacity for their ultimate population of 53,500, the estimated costs of such expansions (at present prices) would be \$869,500. It would then be necessary to give primary treatment to the sewage from the 111,500 ultimate population not in areas tributary to the present treatment plants. It is estimated that a primary treatment plant for 111,500 population would cost \$970,000.

If the costs of Alternates 1-G and 2-G reflect the inclusion of primary treatment for all untreated sewage reaching the river, the total costs exclusive of laterals would be \$3,930,000 for Alternate 1-G, and \$3,609,500 for Alternate 2-G, or a cost for the former \$320,500 in excess of that for the latter.

With an assumed average economic life of 50 years and an assumed interest rate of 2-1/2 per cent, the annual charges for interest and amortization payment would be \$11,300. This is clearly less than the difference in annual operating costs for the five treatment plants of Alternate 2-G as compared to those for the single primary treatment plant of Alternate 1-G. As a consequence, even when consideration is given to the possibility of ultimate primary treatment, the annual costs are favorable to Alternate 1-G.

Mississippi River Stage and Trunk Sewer Capacity: Pipe sizes for the Gravois Creek trunk sanitary sewer have been determined by a hydraulic gradient originating against the water surface in the Mississippi River at the mouth of Gravois Creek when the stage at Market Street is 25.0. Since these are sanitary sewers they will have to function against virtually all stages.

An examination of the topography along Gravois Creek indicates that the hydraulic grade could safely reach elevation 420 at about Station 162+00 which is near the northwest end of Mount Olive Street, approximately 1,100 feet southeast of Union Road. For this condition the design flows could still be handled up to and including stage 30.7. In the period 1861-1949 there have been 406 days at or above stage 30.7, or 4.6 days per year on the average, or 1.83 per cent of the time.

Seventy per cent of the design flows could be discharged by gravity against stage 38.6. The design flow rate represents the probable peak rate which is about twice the average rate. In other words against stage 38.6

there could be discharged by gravity about 140 per cent of the average flow rate from the total design population. In the period 1861-1949 there have been about 13 days at or above stage 38.6, or less than 0.15 day per year on the average, or less than 7/10 of one per cent of the time.

The preliminary designs are satisfactory in the light of the above findings concerning their behavior against river stages above 25 on the Market Street gage.

Local Treatment: It would, of course, be possible to provide the Gravois Creek watershed with a multiplicity of small sewage treatment plants as various parts of the watershed develop. The total ultimate population of the watershed for purposes of designing the trunk sewer has been estimated at 165,000 persons. Information given above concerning the existing treatment plants after they have been expanded, indicates they could handle approximately 53,500 population. This would mean that, of the ultimate population, 111,500 population would require new sewage treatment plants. At the conservative figure of \$30.00 per capita for small complete treatment plants, it can be seen that an additional \$3,345,000 worth of treatment plants would be required. To this, of course, would have to be added the cost of the collecting sewer to each plant. When there are also considered the operational disadvantages of many small treatment plants, along with their high per capita operating costs, it is plainly evident that a scheme of this sort, that is, requiring a multiplicity of small treatment plants, is both costly and undesirable.

Lateral Sewers: In evaluating the probable cost of lateral sewers, it has been recognized that the following areas are, at present, provided with satisfactory lateral sanitary sewers:

Kirkwood	2,250	acres
Oakland-Southwest		
Webster	950	"
Russell & Company	250	"
Afton Sewer District	630	"
13 small areas	340	"
Total:	3,420	acres

Taking this acreage from the total in the entire watershed, which is 13,500 acres, results in a gross unsewered acreage of 10,080. On the assumption that approximately 20 per cent of this acreage will be required for streets, roads, and other public purposes, and another 20 per cent will be served by the proposed trunks and sub-trunks, or is of a character such as the flood plain of the main creek which would be undevelopable, there remain 6,000 acres presently unsewered and estimated to ultimately require lateral sanitary sewers. At the unit cost of \$500 per acre for lateral sanitary sewers, the aggregate for these 6,000 acres is \$3,000,000. Obviously, laterals will only be constructed as developments occur.

Recommendations: In view of the foregoing, it is recommended that the Gravois Creek watershed can be best and most efficiently served by a gravity system of sanitary sewers consisting of a trunk along the valley of Gravois Creek from the outlet of the Kirkwood system above its present treatment plant to the Mississippi River, with sub-trunks to by-pass all existing treatment plants and to provide outlet service for the lateral collecting system necessary for the undeveloped areas as developments occur; that if the U. S. Public Health Service or the State Board of Health ultimately require treatment, it is expected that such treatment will consist of primary treatment only and that a plan of providing such treatment on the banks of the Mississippi River for the flow from the entire watershed will be the most economical and most efficient to operate. The estimated cost of the plan of trunk and sub-trunk sewers on the basis of this recommendation is \$2,610,000.

General Obligation Bonds: A takeoff of the valuations now current in St. Louis County for the improvements and areas embraced in the Gravois Creek watershed indicates a total of \$23,000,000. Under the laws now prevailing for sewer districts in St. Louis County, the maximum debt which can be incurred is limited to 5 per cent of the assessed valuation if voted by a two-thirds majority vote. The total which can be raised on this basis is therefore \$1,150,000. It is apparent that revision of the laws will be required in order to carry out the suggested program if it is to be financed entirely by General Obligation Bonds.

Sewer Rental Bonds: At present the State Constitution does not provide for financing sewer construction by revenue bonds. However, should such legislation be approved and should provisions be contained in such legislation to permit the construction and financing of sanitary trunk outlet sewers, it would be possible to finance the proposed construction of the Gravois Creek trunks and sub-trunks by the issuance of Sewer Rental Bonds. The present population of Gravois Creek, which is estimated at 34,000 is equivalent to 9,000 families. On the assumption that generally the improvements in this valley consist of individual units for families, and the assumption that the interest rate for Sewer Rental Bonds may be on the order of 4 per cent, the necessary annual carrying charges for interest and sinking fund on the basis of \$2,610,000 for trunk and sub-trunk sanitary sewers would involve an annual charge of approximately \$180,000, or an annual rental charge per family of \$20.00. Of course it would be necessary to supplement this construction and financing by the issuance of special assessments or by the private construction of lateral sewers as the tributary area to these trunks develops.

Financing Contruction: It would therefore appear feasible to finance the trunk and sub-trunk construction by the issuance of Sewer Rental Bonds or by the issuance of General Obligation Bonds if the laws were changed to permit Sewer Rental Bonds or to permit the issuance of General Obligation Bonds in the amount of approximately 10 per cent of the assessed valuation.

B - St. Louis County Area Tributary to the Main River Des Peres Channel between the Watershed Lines of Gravois Creek and Deer Creek: Table I-9 indicates the areas included under the above heading. There also are shown in that table the sewerred and unsewerred areas.

Utilizing the criterion of 3:1 slopes to determine the extent of any trunks or sub-trunks required, it was found necessary to develop preliminary plans (Fig. 3) and profiles (Fig. 7) for a trunk to serve the proposed Lakewood Sewer District. This trunk would connect to the City of St. Louis River Des Peres foul water sewer. Designs and cost estimates have also been prepared for a trunk (Figs. 3 and 8) along the northern edge of the area discussed herein, paralleling in great part the existing Webster Groves Sanitary District sewer which is built on the north side of the main draw, with the proposed sewer constructed largely in the south bank. This sewer would serve the southeastern part of the City of Webster Groves area north of Watson Road and west of Laclede Station Road, and the Marlborough area, both of which, together with the balance of the tributary area, have been considering the construction of a trunk sanitary sewer such as is herein proposed to serve the presently developed and future areas with a connection to the City of St. Louis River Des Peres sanitary sewer.

The proposed Lakewood Sewer District trunk sewer has been estimated to cost \$24,000 (see Table I-16). The Marlborough or S.S. Peter and Paul Cemetery trunk as the other sanitary sewer has been designated is estimated

to cost \$68,000 (see Table I-16). An initial payment for connection charges to the City of St. Louis for outlet service to the river is estimated at \$20,000.

In Table I-9, 1,400 acres are assumed presently unsewered. For the same reasons given in discussing the Gravois Creek watershed laterals, approximately 60 per cent of the 1,400 acres has been assumed to ultimately require lateral sewers. The cost estimate for providing these is \$425,000.

The total estimated cost of trunk sewers and connection charges is therefore approximately \$112,000, which can be financed well within the 5 per cent limitation of the assessed valuation permitted under the present law for sewer districts in St. Louis County. As a matter of fact the valuation as taken off from the school districts assessments would indicate that General Obligation Bonds could be issued to permit the construction of not only the trunks, but all of the laterals on the basis of estimated cost for lateral construction of \$425,000.

The estimated population presently residing in this area is 4,700 or approximately 1,200 families. If Sewer Rental Bonds were issued in the amount of \$112,000 for this construction, the annual service charge per family would be on the order of \$6.50 for the trunk sewers.

It is therefore apparent that financing of the necessary trunk and lateral facilities in this area is feasible either under the present laws or under Sewer Rental Bonds if the State legislature passes the necessary legislation to permit the necessary construction by Sewer Rental Bonds.

C - Deer Creek Watershed: With the exception of future lateral sewers which will be necessary when the area develops, the entire Deer Creek watershed generally east of Warson Road is adequately served. As stated in Section 2 under Description of Existing Utilities and as shown on Fig. 2, the required sanitary facilities have been provided by either the municipalities or sanitary sewer districts established in this area. In the Two-Mile Creek District, as developments occur requiring lateral sewer construction, such sewers have been built by the property owners or subdividers involved, such lateral sewer construction will be necessary in the area to the east of Huntleigh Village and in the area within the Two-Mile Creek District west of Huntleigh Village, the northwestern corner of Kirkwood, and in the Village of Des Peres. Within the City of Ladue, the McKnight Village Sanitary Sewer District and the Ladue-Deer Creek Sanitary Sewer District have provided trunk sanitary sewer facilities for the entire city adequate to take care of the sanitary flow from east of Geyer south of Clayton Road and east of Spodee and north of Clayton Road. This includes the eastern portion of the Village of Frontenac to the north of the Two-Mile Creek Sanitary Sewer District. As also stated in Section 2 under the present zoning, the area to the west of Spodee Road zoned for one-acre tracts can be adequately served with individual septic tanks followed by filter beds and no coordinated collecting system will be necessary. However, if the zoning is changed in the future so that the Villages of Frontenac and Creve Coeur require sanitary sewers, it will be necessary to also provide treatment plants as the sewer systems to the east have not been designed to take sewage flows from these areas. No estimates of cost for sanitary facilities required beyond Spodee Road are therefore presented, as if sewers become necessary it would be entirely a local matter to the areas involved.

The present population residing within the Deer Creek watershed is estimated at 91,700, and the current valuation of lands and properties within this watershed is approximately \$108,000,000.

D - The Main Branch of the River Des Peres Watershed through and North and West of University City: To supplement the existing sewerage facilities in this watershed, it will be necessary to construct an extension of the trunk sanitary sewer west of University City, together with a sub-trunk in Woodson Road as shown on Fig. 3. Profiles of these are shown on Fig. 9.

Table I-10 summarizes the information concerning existing sewerage in the area, and it will be noted that 4,451 acres are presently unserved. Due to the character of this area, 70 per cent of the gross unserved area has been assumed to ultimately require lateral sewers.

Construction drawings have previously been prepared for the Wellston Sewer District area and, from these, a preliminary estimate based on present costs indicates a total for sanitary sewers only for the entire area within the sewer district, including connection charges to the City of St. Louis of \$650,000. As shown in Table I-10, an additional 2,150 acres, of which 660 are in unincorporated areas, will require lateral sewers at the total cost given in that table. For the use of University City and the City of St. Louis outlet facilities, these 2,150 acres are estimated to have a connection charge of approximately \$165,000. The trunk sewer in the main valley above University City, along with the sub-trunk required to connect to the outfall of the South Lackland Sewer District, are estimated to cost \$133,000. (See Table I-17.) These estimates assume that the proposed trunk sewer will start at the western limits of University City. It is expected that the present outlet which ends at 82nd Street and Olive Street Road will be extended to the city limits in the near future.

An alternate estimate was prepared to obtain the cost of the same length main trunk sewer with a lesser length sub-trunk in Woodson Road on the assumption that the South Lackland Sewer District would continue the existing practice of pumping all sewage originating in the sewer district over to the sewers of the St. John's-Overland Sewer District which provides sewage treatment for all of the sewage originating in both districts before discharging the effluent into the upper end of Coldwater Creek. The trunk sewers under this alternate would cost \$89,000 (see Table I-17). The additional cost of \$44,000 (not all of which is chargeable to the South Lackland Sewer District since some is necessary to serve the sub-watershed itself) for abandoning the pumping of the South Lackland District sewage out of the watershed is considered a lesser amount than the capitalized charges for pumping and for service through the St. John's-Overland Sewer District sewers, including treatment in the latter sewer district's treatment plant. As a consequence, the scheme of trunk and sub-trunk providing gravity outfall service for the South Lackland District in its own watershed is recommended for the adopted master plan.

On Table I-10 is shown a summary of costs to provide sanitary trunk sewers for the presently unsewered area in the River Des Peres watershed exclusive of University City. The total cost as shown, including a system of sewers for the Wellston area is over two million dollars. The total assessed valuation for the River Des Peres watershed, exclusive of University City and the areas to the south of University City directly tributary to the River Des Peres combined sewer and the present sewer districts which have provided sanitary facilities, is estimated at approximately \$36,000,000. If General Obligation Bonds are authorized in the amount of 5 per cent of the assessed valuation, the total which can be voted would be \$1,800,000 or somewhat less than the total estimated cost necessary for the sanitary sewer facilities required as shown in Table I-10.

E - Watkins Creek Watershed: The Watkins Creek watershed at the north end of St. Louis County is entirely unsewered at present, and virtually all of the acreage upstream from Bellefontaine Road is zoned for developments of one acre or larger per family. As a consequence, the recommended plan for sanitary sewers in this watershed involves a trunk sewer with no capacity for this upper area. The recommended trunk sewer would cost \$129,000 (see Table I-28). It will be noted on Fig. 10, which shows the preliminary profiles for this trunk that a design had also been prepared for a trunk sewer collecting from the entire acreage including that of one acre or larger units. This, however, has not been incorporated in this report since the earlier mentioned criterion permits exclusion of an area of this character when it is at the upper end of a watershed.

It will be noted in Table I-11 that 60 per cent of the gross unsewered area has been assumed to require lateral sewers after complete ultimate development. These are estimated to cost an aggregate of \$700,000.

There will also be noted in the estimates an item for complete treatment for 17,000 ultimate population. This is necessitated by the fact that Watkins Creek discharges only a short distance upstream from the intakes of the City of St. Louis waterworks at Chain-of-Rocks on the Mississippi River. Such a plant, which would have to provide complete treatment, is estimated to cost \$550,000.

Pipe sizes for the trunk sanitary sewer in the Watkins Creek watershed have been determined by the hydraulic gradient starting at the water surface in the Mississippi River corresponding to stage 25.0 at Market Street. However, these are sanitary sewers which must function against all stages.

An examination of the topography above the main valley indicates that the gradient could safely reach about 455 at Station 105+00 which is about 3,600 feet downstream from the CB&Q Railroad. For this condition, the design flows could be discharged against a stage of 31.4 feet or less. In the period 1861-1949, there have been 328 days at or above stage 31.4, or 3.7 days per year on the average, or 1.0 per cent of the time.

Seventy per cent of the design flow rates could be discharged by gravity against the tentative standard project flood which corresponds to stage 47 at Market Street. This represents about 190 per cent of the average flow rate from the entire design population (the maximum rate is assumed to be 2.8 times the average rate).

The preliminary designs are satisfactory in the light of the above findings on the probable capacities at stage above 25 which is that against which hydraulic grades were developed for size of the preliminary designs.

It is possible that studies for final construction of sanitary facilities in the Watkins Creek watershed might find it advisable to divert the sanitary flow from the bulk of the watershed through a tunnel line into the Maline Creek watershed. Certainly thorough consideration of this alternate would be desirable at the time of development of specific plans. This would obviate the necessity for treatment of almost all of the sewage originating in Watkins Creek watershed since the Maline Creek outlet is downstream from the water-works.

The total cost for trunk sewers for the Watkins Creek watershed is \$129,000. If this trunk sewer discharges into the Mississippi River above the Chain of Rocks water-works it will be necessary to provide treatment. On the basis of the ultimate population estimated at 17,000, such treatment is estimated to cost \$550,000. However, the present population in the Watkins

Creek watershed is only 2,400. If a trunk sewer is constructed in the near future, a treatment plant of much smaller capacity than that estimated for ultimate population could be provided which could be expanded by constructing additional units as necessary. The current valuation within Watkins Creek watershed is approximately \$1,800,000. On the basis of the present limitations for General Obligation Bonds of 5 per cent of the assessed valuation, only \$90,000 could be voted. To provide the trunk sewer and modern treatment plant along the banks of the Mississippi River would require the financing by both General Obligation Bonds supplemented by Sewer Rental Bonds, with General Obligation Bond authority modified to at least 10 per cent of the assessed valuation.

F - Maline Creek Watershed: Alternate designs of sanitary trunks and sub-trunks have been made considering the watershed by itself. As is true in the case of Gravois Creek, Alternate No. 1-M assumes abandonment of the existing sewage treatment plants of the Walton Road Sewer District, and the Ferguson Sewer District. The trunk sewer in this case would have to connect to the outfall ahead of the existing Walton Road Sewer District treatment plant. There would also be required a connection to the lower end of the Carsonville Sewer District outfall near the partially completed, but inoperative, Carsonville treatment plant. The Ferguson treatment plant would likewise have to be by-passed with all sewage discharging into the proposed trunk sanitary sewer in the main Maline Creek valley. A sub-trunk is required to connect to the outfall for the Normandy Sewer District at the upper end of the watershed. Only five other sub-trunks are necessary under the criteria discussed earlier in this report. One would be required to serve the area largely within the new community of the City of Bellefontaine Neighbors; this has been designated the Bissell sub-trunk. The second sub-trunk serves the

St. Ferdinand area. The largest of the sub-trunks drains the Black Jack area with a branch coming off in the vicinity of Chambers Road. At Ardmore Avenue a sub-trunk is required to serve the area coming from the north in that draw. A very short sub-trunk is necessary near Highway 99 and the main creek. Figs. 3, 11 and 12 indicate in plan and profile the proposed trunk and sub-trunks.

Considering the Maline Creek valley alone, Alternate 1-M, which assumes no treatment of any sewage in the watershed, involves a cost for the main trunk of \$1,320,000, and for the sub-trunks of \$306,000 (see Tables I-25 and I-27).

Alternate 2-M is based upon the assumption that the existing treatment plants will continue in operation and will be expanded to the ultimate design population capacities as the need arises. Figs. 3, 12 and 13 show in plan and profile the proposed trunk and sub-trunks. Herewith are the pertinent figures on present and ultimate design populations, and estimated costs for the additional population capacity for each of the two plants.

ADDITIONAL COSTS TO EXPAND EXISTING TREATMENT PLANTS:

Plant	Population		Increase in Pop.	Per Capita Cost	Additional Cost
	Design	Ultimate			
Walton Road	6,500	11,000	4,500	\$30.00	\$135,000.00
Ferguson	7,500	14,500	7,000	30.00	210,000.00
Total					\$345,000.00

Summarizing the cost of Alternate 2-M:

Main trunk	\$1,105,000 (see Table I-26)
Sub-trunks	306,000 (see Table I-27)
Additional cost to expand existing treatment plants	<u>345,000</u>
Total . . .	\$1,756,000

This total is \$130,000 greater than that for Alternate 1-M, and clearly suggests that Alternate 1-M, which includes no sewage treatment is the less

costly of the two plans studied; and, of course, Alternate 2-M also would have chargeable against it the operating costs for the treatment plants. Laterals would cost the same under either alternate.

There was also developed an approximate cost for providing a great many small treatment plants throughout the watershed which has been estimated to have an ultimate population of 164,000. Subtracting from this figure the ultimate population of the two treatment plants, which has been estimated at 25,700, the remaining population requiring satisfactory sewage treatment would be 138,300 people. Assuming an average per capita cost of \$30.00, this results in a total of \$4,149,000. To this would, of course, have to be added the cost of collecting sewers to each of the plants. This is very clearly an uneconomic solution of sanitary problems of the watershed, and many small plants are inefficient and costly from an operating consideration.

It will be noted later that the recommended plan for the Maline Creek watershed involves the design of sufficient capacity in the Maline Creek trunk sewer below Ardmore Avenue for the sanitary sewage from Coldwater Creek watershed above and including the City of Florissant. This combined scheme will be discussed subsequently.

The current estimated valuation as ascertained from County records is approximately \$30,000,000, which can provide on the basis of the present constitutional limits of 5 per cent of the assessed valuation, General Obligation Bonds in the amount of \$1,500,000 as compared to the estimated cost of trunks and sub-trunks under Alternate Plan 1-M of \$1,626,000.

The present estimated population residing in the Maline Creek valley is approximately 41,400 or 10,900 families. It was assumed that this represents an equal number of housing units and if the financing of the trunks and sub-trunks is made from funds obtained by the issuance of Sewer Rental Bonds,

the annual charge per family would be approximately \$15.00. Sewer Rental Bonds involving such annual charges would be very attractive to the bond purchaser and would probably result in less cost as the interest rate would be less than 4 per cent used in estimating the annual charges.

G - Coldwater-Maline Creeks Watersheds: All of the area tributary to Coldwater Creek below the City of Florissant is zoned for development as one acre or larger parcels per family. It will be recalled that the criterion has been assumed that development of the sparseness indicated by the foregoing does not require or justify the provision of sanitary collecting sewers. Because of this fact, and because an outfall sewer from Florissant to the Missouri River in the main valley of Coldwater Creek would be approximately 53,000 feet in length, both alternate schemes for providing sanitary sewerage facilities for the Coldwater Creek watershed omit from further consideration that portion of the watershed below the City of Florissant. Attention is also directed to the fact that Coldwater Creek discharges into the Missouri River at a point not very far upstream from the Chain-of-Rocks intakes of the City of St. Louis water-works. This would mean that in any event completely untreated sewage could not be permitted to discharge into the Missouri River.

As a consequence, designs and estimates have been prepared for a system of sanitary trunk sewers (Fig. 3) from the upper end of the Coldwater Creek watershed to and across the St. Louis-Lambert Municipal Airport, and thence along the Wabash Railroad eastwardly, and then southwestwardly through the ridge to a connection with Maline Creek in the vicinity of Ardmore Avenue. Almost all of the lower 10,000 feet of this sewer would have to be in tunnel, as is indicated on Figs. 14, 15, 16 and 17 showing profiles for this gravity system. Because of the need to cross existing storm sewers in the airport a lift station would have to be provided at Natural Bridge Road to pump the

collected sewage from the gravity system above Natural Bridge Road, into the shallow trunk sewer across Lambert Field. This scheme involves no treated sewage, and consequently the upper trunk and sub-trunks above Natural Bridge Road will have to extend and connect to the existing outfall sewers for the City of St. Ann and the St. John's-Overland Sanitary Sewer District.

Sewer originating north of the Wabash Railroad, which is along the northern edge of the airport, would be collected in a gravity trunk and sub-trunks, and all delivered to a point near the downstream corner of Florissant where a lift station would pump the flows through a force-main back up to the gravity outlet which runs eastwardly along the Wabash Railroad, and thence through the proposed tunnel to the Ardmore connection with the Maline Creek main trunk sewer. It will be noted that this scheme avoids the need for treatment by bringing the Coldwater Creek sewage to the Maline Creek sanitary trunk for gravity disposal in the Mississippi River below the Chain-of-Rocks water-works.

Pipe sizes for the combined Maline-Coldwater trunk sanitary sewer have been determined by a hydraulic gradient originating against the water surface in the Mississippi River at the mouth of Maline Creek when the stage is 25.0 at Market Street. Since these are sanitary sewers they will have to function against virtually all stages.

An examination of the topography along Maline Creek indicates that the hydraulic grade could safely reach about elevation 144.0 (bankfull) in the vicinity of Station 122+00 about midway between Highway 99 and Hall's-Ferry Road. For this condition, the design flows could still be handled up to and including stage 37.2 which has had a duration at or above this of about 30 days in the period 1861-1949 or less than 1/10 of one per cent of the time.

Stage 44 is designated by the Corps of Engineers as that for the "50-year flood confined." Against this stage, the preliminary design sewers could discharge about 70 per cent of the design flow rate. For the ultimate population the complete design flow rate represents the probable peak rate which is about twice the average rate. In other words, against the "50-year flood confined" the sewers of the preliminary design could discharge 140 per cent of the probable average flow assuming ultimate population in the two watersheds.

The preliminary designs are acceptable in the light of the above findings concerning their behavior against river stages higher than 25 at Market Street.

As an alternate to this combined plan, preliminary designs and estimates have been prepared for a scheme in the Coldwater watershed alone, involving retention and ultimate expansion of the existing sewage treatment plants. There follows the information concerning present and ultimate population capacities for the existing treatment plants, together with estimates for enlarging the St. Ann and St. John's-Overland plants. The additional capacity required for the Florissant sewage treatment plant at the time of ultimate development can more profitably be handled as a part of the large plant required at the lower end of Florissant.

ADDITIONAL COSTS TO EXPAND EXISTING TREATMENT PLANTS:

Plant	Population		Increase in Pop.	Per Capita Cost	Additional Cost
	Design	Ultimate			
St. Ann's Village	3,200	5,400	2,200	\$30.00	\$ 66,000.00
St. John's- Overland	12,000	21,700	9,700	25.00	242,500
Airport	10,000	10,000			
Florissant	2,500	19,600	17,100*		

*Included in estimated cost for large plant.

Total \$308,500.00

Proposed treatment plant lower end of Florissant, estimated ultimate population 110,250 at \$22.50 equals approximately \$2,500,000.

The main trunk under this alternate will start at Dawson Creek and collect from the tributary watershed down to Natural Bridge Road where a small lift station will again be necessary to pump the flows into the shallow sanitary sewer across the airport. A gravity line continues from the north edge of the airport in the main valley down to the downstream corner of the City of Florissant, at which location the larger treatment plant would be required. In addition to the Dawson Creek, St. Charles Rock Road, Elm Grove and East Airport sub-trunks, required for the alternate with no sewage treatment (existing treatment plants all assumed to be by-passed), there will be required Kinloch Park and Hazelwood sub-trunks. Figs. 3, 17 and 18 show respectively, the plan and profiles of the trunk and sub-trunks.

The cost estimates for the preliminary designs of sanitary facilities for the Coldwater Creek drainage area alone result in the following:

Coldwater Creek main trunk	\$ 901,000
Coldwater Creek sub-trunks	195,000
Coldwater Creek sewage treatment plant, 110,000 population	2,500,000
Additions to St. Ann's and St. John's-Overland treatment plants	<u>308,500</u>

Total: \$3,904,500

In Table I-12, giving the costs for the combined Coldwater and Maline watersheds, the total costs for the Maline-Coldwater trunks, sub-trunks, lift stations and force-main are \$4,823,000. If there is subtracted from this figure \$1,626,000, which represents the cost for the Maline Creek trunk and sub-trunks under Alternate 1-M, excluding, however, the Ardmore Branch, there results a difference of \$3,197,000 which represents the costs of the combined system chargeable to Coldwater Creek alone. All of these figures do not include the cost of laterals which would be allocated to the specific watersheds themselves under any scheme of trunk sewerage.

Thus it can be seen that the scheme involving no treatment of sewage with gravity disposal through a common outfall down the Maline Creek valley is cheaper in capital costs by \$707,500 insofar as Coldwater Creek itself is concerned. Again as was the case for Gravois Creek, consideration of probable operating expenses for the expanded existing treatment plants and for the large proposed treatment plant in Florissant would further weight against the adoption of the scheme requiring sewage treatment. This is true even though a considerable operating expense would be involved in the lift stations at Florissant and at Natural Bridge Road. This latter lift station would be necessary in any scheme of sanitary sewerage of the area. The operating costs for the lower lift station at Florissant would entail very much less cost for operating personnel and would be less in annual amount than that required for operating the three sewage treatment plants.

In recognition of the possibility that at some future time, primary treatment may be required for all sanitary sewage before discharge into the Mississippi River, estimates have been prepared in a manner similar to that used for Gravois Creek watershed.

For the scheme involving the by-passing of all existing sewage treatment plants in the combined Maline-Coldwater system, the overall costs including a primary treatment plant at the Mississippi River for an ultimate population of 320,700 (but excluding the cost of laterals) are \$7,073,000.

If the Walton Road, Ferguson, St. John's-Overland Sanitary Sewer District treatment plants, and those serving the towns of St. Ann and Florissant, and the Airport treatment plants are all retained and expanded for the ultimate populations tributary to each (except that the required expansion of the existing treatment plant for the City of Florissant will be taken care of by making the proposed large complete treatment plant at the downstream corner

of Florissant have a capacity such that the required expansion of the Florissant plant will be handled by the large new plant), all sewage originating in the watershed of Coldwater Creek above and including the City of Florissant, will be given satisfactory treatment.

In the Maline Creek watershed there would remain 139,000 population in the areas not served by any expanded existing sewage treatment plant. Including primary treatment for this population, the total cost of the Maline and Coldwater Creeks sanitary facilities would be \$6,815,600.

The difference in cost of construction of sanitary trunk and sub-trunk sewers for the combined Maline-Coldwater Creeks systems with primary treatment only, of approximately \$260,000 over the cost of maintaining enlarged existing treatment plants and a new treatment plant on the Coldwater Creek below Florissant, and separate systems of trunks and sub-trunk sewers for each watershed, with a primary treatment plant at the mouth of the Maline Creek trunk, will be more than offset by the increased operating cost of the treatment plants under the separate systems.

For the foregoing reasons, the recommended Master Plan for Sanitary Sewers involves combining the Maline and Coldwater Creeks watersheds by means of a tunnel through the ridge between them and by-passing all existing treatment plants. No sewage will be treated under the recommended Master Plan, unless there is ultimately required primary treatment before discharge into the Mississippi River.

The estimated cost of the recommended plan for combined outlet trunk and sub-trunk sanitary sewers for the entire Maline Creek watershed and for the Coldwater Creek watershed from the headwaters to and including the City of Florissant on the basis of by-passing all existing treatment plants is \$4,823,000. The total assessed valuation of the Maline and Coldwater Creeks watersheds is approximately \$80,000,000. Under present constitutional limitations of 5 per cent of the assessed valuation, only \$4,000,000 in General

Obligation Bonds could be authorized. If the present limitation is modified by the state legislature to permit 10 per cent of the assessed valuation to be voted, a sufficient sum could be raised to finance the proposed sanitary trunk sewer and primary treatment construction. The present populations within the Maline and Coldwater Creeks watersheds approximately 82,000, or 21,500 family units. If the proposed construction is financed by Sewer Rental Bonds estimated to bear 4 per cent interest, an annual charge of approximately \$335,000 would be required, or, on the basis of 21,500 family units, approximately \$16.00 annual charge per family.

Section 6 - Cost Estimates for Sanitary Sewerage: The cost estimates for each of the major watersheds in the County are summarized in Tables I-8 to I-12, inclusive. Detailed estimates for each of the trunks and sub-trunks and treatment plants are presented in Tables I-13 to I-28, inclusive.

The unit prices used for the items entering into the detailed estimates reflect current costs for each of the items. The percentage of total excavation assumed as rock is a judgment figure predicated upon experience and general understanding of the character of the County sub-soils. It will be noted that approximately 15 per cent of the estimated construction cost has been assumed to cover contingencies, engineering, inspection, etc. Right-of-way costs for land acquisition incident to the construction of the sewers are judgment figures.

The cost of lateral sewers has been predicated upon the following considerations. It has been assumed that lateral sewers will be 8-inch, 10-inch, and 12-inch diameter pipe. It has further been assumed that, on the average, about 250 lineal feet of 10-inch pipe will be required for each two acres of net area to ultimately be sewered; that is, each 250 feet would serve an acre either side of it. Based upon current costs, it has been estimated

that pipe, 10 inches in diameter, laid at the usual depth for sanitary service, will cost \$4.00 per lineal foot, complete in place, including excavation and backfill and incidentals such as the provision of Y-junctions and man-holes. Thus the unit cost for lateral sewers has been estimated as \$500 per acre.

Sewage treatment plant costs have been based upon a paper by C. J. Velz, appearing in Engineering News-Record, Vol. 141, No. 16, page 84 (October 14, 1948). This paper translated the actual costs of 185 existing sewage treatment plants of various types to a common 1926 base cost per million gallons per day, assuming 100 per cent removal of B.O.D. (Biochemical Oxygen Demand). These plants were distributed throughout the eastern and middle parts of the United States. There had also been set up in this analysis assumed percentages of B.O.D. removal for each of the usual types of treatment as follows:

Activated sludge	90%
Trickling filter	85%
Chemical coagulation	65%
Primary treatment	35%

In utilizing the graph, it is entered for the number of mgd in the specific plant for which an estimate is desired. A base figure per million gallons per day (mgd) is read from the chart. This is then multiplied first by the Engineering News-Record construction cost index as related to 1926 assumed to be 100. The current ENR construction cost index is 250%. This product in turn is multiplied by the assumed percentage of B.O.D. removal required for the type of plant selected and, in turn, that product is multiplied by the number of mgd capacity of the plant for which a cost estimate is desired. The resulting figure was rounded to give the costs shown and discussed in the report.

The lift stations required in the Coldwater-Maline system were based upon cost estimates assuming the following conditions. In the case of the large station at the north edge of Florissant, the expected peak flow rate, for which the collecting sewer was designed, is 33 cfs or 14,850 gpm. This station was designed, assuming three 7500 gpm pumping units, each capable of delivering that quantity against 125 feet total dynamic head. Horizontal, centrifugal, double suction pumps, direct driven by 300 horsepower, 1150 RPM electric motors have been assumed. One of the three pumps would be a standby unit. Approximate installed costs for the pump, motor, and starter have been estimated, and from experience in designing other similar stations a factor was used to multiply the installed equipment costs to achieve the overall cost of the entire pumping station, including the structure, all necessary piping, and electrical controls. For the Florissant plant, this resulted in a cost of \$114,000 for the station.

In the case of the lift station required at Natural Bridge Road, the peak flow rate for the recommended plan, involving no sewage treatment, is 35.4 cfs, or about 16,000 gallons per minute. For this condition the estimates assume three 8,000 gpm, vertical, mixed flow, volute type pumps, each driven by a 75 horsepower electric motor capable of delivering the rated flow against 25 feet total dynamic head. This station would cost \$77,000, including all equipment, the structure, the piping, valves and fittings, and electrical controls.

For the Coldwater system, only, involving retention and ultimate expansion of the existing sewage treatment plants, together with the construction of a large complete treatment plant at the north edge of Florissant, there would be required only the lift station at Natural Bridge Road. Under this scheme the peak rate of flow drops to 14.6 cfs or slightly less than 6600 gpm

at Natural Bridge Road. For this station, there have been assumed three 3500 gpm. pumps of the vertical, mixed flow, volute type, each driven by a 40 horsepower direct connected electric motor. The all-inclusive cost for this pump station has been estimated as \$40,000.

Under actual design for construction purposes, consideration should be given at Natural Bridge Road and Coldwater Creek to minimizing the amount of flow requiring pumping. To accomplish this, it is possible to provide a shallow collecting sub-trunk upstream from Natural Bridge Road, such that the majority of the tributary area can be connected directly by gravity sewers to this high level sub-trunk. The areas immediately contiguous to the main stream of Coldwater Creek for a limited distance upstream from Natural Bridge Road could then be provided with a deep sub-trunk leading to a lift station, which, in turn, will discharge the flows from this deep main into the shallow trunk crossing the airport. Detailed consideration might well reveal that the annual costs for this scheme would be less than those involved in pumping the entire peak flow at Natural Bridge Road.

In establishing the costs for the force-main and lift station at the downstream corner of Florissant, a preliminary study of three pipe sizes - 36", 30", and 24" in diameter - indicates that the 30" pipe is the most economical in annual costs covering both interest and depreciation at an assumed rate of 3 per cent with a 100-year life for the force main, and power costs for overcoming both friction and static heads based on average flow rates estimated from the design data. (It was assumed that the peak sanitary flow rates would be about 2.3 times the average.)

PART II

STORM DRAINAGE

Section 1 - Topography of St. Louis and St. Louis County

The original natural drainage of the central portion of St. Louis, roughly a semi-circle of about three miles radius around the business district, was through separate water courses draining eastwardly to the Mississippi River and with the drainage area situated entirely within the limits of the City of St. Louis. To the north and south of this central semi-circle, the natural water courses have their source in St. Louis County and drain eastwardly to and through St. Louis to the Mississippi River. In this category are the areas drained by the Harlem and Baden Systems to the north and northwest, and by the River Des Peres-Deer Creek System to the south and west. The drainages in this category, therefore, are distinctly a common problem of the City and County.

North and northwest of this last section lie the main valleys of Maline Creek draining to the Mississippi, and of Cold Water Creek draining to the Missouri. South of the second group is the drainage of Gravois Creek which has its source in Kirkwood and drains into the River Des Peres near its mouth. The watersheds of all three of these drainages are almost entirely within St. Louis County, and drainage problems in these areas are primarily County problems. The relative position of these different areas are shown on Fig. 1.

Section 2 - Present Drainage Facilities

A. City of St. Louis: The City of St. Louis has developed a complete system of artificial storm drainage through the construction of combined sewers. In general, these combined sewers follow the course of the earlier streams, and represent complete enclosure of, and removal of, the natural water courses. The City's program of constructing large trunk sewers along these water courses was begun about 1850, and was substantially finished as of about 1930, when the construction of the tremendous storm sewers through Forest Park and up to the University City line, near Delmar Station, was completed.

The combined sewers for the inner area naturally drained only St. Louis territory. Those for the second or intermediate areas drained also St. Louis County territory, and were constructed up to the city limits where provision was made to take in the natural water courses in St. Louis County.

Since this program extended over a period of 100 years, the standards of drainage design have varied considerably. In general, sewers built under the latter years of the program were given relatively larger capacity than those of the early construction period.

In general, none of these closed sewers have drainage capacity corresponding to present standards of flood flow protection, and overcharge of sewers, resulting flooding, and damage to property has been experienced for many years, and such occurrences have steadily been becoming more frequent.

The inadequacy of the City sewers and the related damage to property resulted in development of a program of relief on supplementary sewers which was started about 1910. The City of St. Louis has spent millions of dollars on such relief sewer construction. As part of a continuing program of such a construction, at the present time, it actually has a considerable

sum of money out of bond issue funds at present available. This situation is summarized in more detail hereafter.

The present standards of storm drainage capacity of the City of St. Louis provide sewers expected to be overcharged on the average only about once in twenty years. Practically none of the City's storm drainage trunk lines have such capacity at the present time, many of these lines being subject to overcharge as often as once or twice a year, and the more adequate lines on the average of once in five to fifteen years.

While the City's program will provide eventually for bringing all trunk line storm drainage in the inner group up to this standard, and while the City is apparently prepared to eventually finance such a program, the situation with respect to trunk storm drains in the second class, that is, those draining areas in St. Louis County, is greatly complicated. This involves a joint problem of the City and County which requires serious consideration and planning. It is presented in more detail in the succeeding section.

Section 3 - Storm Drainage for Areas Lying both in St. Louis and St. Louis County

The areas in this class are outlined in Fig. 1. It will be seen that they fall into two distinct groups. These are the Harlem-Baden Drainage Systems to the northwest of the central St. Louis area, and the River Des Peres-Deer Creek System to the south and west of that area.

Section 4 - Harlem-Baden Drainage System

This drainage system involving two contiguous natural valleys, each with two main branches, is shown in outline on Fig. II-1. The lower portions of the trunk sewers of these systems were constructed by the City of St. Louis in the period from 1905 to 1910. The extension of the Harlem trunk lines was carried out by the City of St. Louis between 1910 and 1920, and similar structures were provided in the Baden area between 1910 and 1925. For each of the four main branches, large combined sewers were constructed up to the St. Louis city limits, with provision for introducing the flow from the creeks in St. Louis County into their upper ends.

No action to extend these trunk services was undertaken by St. Louis County or by any of the municipalities in St. Louis County in these watersheds. In the 1930's, however, four sanitary districts were incorporated which covered the greater part of the County portion of these drainages. These sanitary districts were incorporated under the County Sanitary District Act with the primary purpose of providing systems of sanitary sewers. All of these districts, however, took advantage of Federal funds available under WPA and PWA programs, and proceeded to construct continuing combined sewers westward from the ends of the St. Louis sewers at its city limits. Principal trunk lines, which resulted from this program, are outlined on Fig. II-1.

Actually, in three of the districts nearly complete storm drainage was provided, including laterals. In the two northern districts, lying in the County portion of the Baden watershed, complete storm drainage was provided only for the portion of the district adjacent to St. Louis.

With respect to the whole of the Harlem-Baden watersheds, the City and County have a joint problem. While the City has paid the original cost of laying trunk lines up to its western limits, and the County sanitary districts have paid the cost of extending these in whole or in part west of the city limits, there is a tremendous problem at the present time which involves the provision of relief sewers for the existing trunk lines, and in some County districts the extension of trunk line storm drainage facilities westwardly from the ends of the existing sewers. In the following section there is presented the results of a preliminary analysis of drainage facilities and requirements in the Harlem-Baden System. The technical analysis has not been worked out in complete detail, but pertinent quantities have been developed with sufficient accuracy to define the magnitude of the problem. The plan of improved storm drainage presented may be taken as a representative adequate plan even though, under later detailed studies, some alternate plan may be found to be more economical and desirable.

In Appendix II-A hereto the manner in which the study of these systems was carried out is presented, and the character and results of the investigation are shown in tabular form. The results of the investigation and description of the suggested preliminary plan of relief sewers is summarized in the following section.

Section 5 - Inadequacy of Trunk Sewers in the Harlem and Baden Systems

On Fig. II-1 there have been outlined the existing skeleton system of trunk sewers, and there is also shown the watershed lines defining drainage areas which this system serves.

In Tables II-1 A and B there is set out pertinent figures with respect to the inadequacy of the existing system. In this table, under the designation "Q", there is shown the calculated storm flow in cubic feet per second at the lower end of each of the principal sections of each of the trunk sewers. This calculated flow is that expected to be equalled or exceeded once in twenty years when the drainage area has been developed to the density of improvement now anticipated. In the column headed "Capacity" there is also shown in cubic feet per second, the capacity of the existing structures. The relation of the present capacity to the calculated flow quantity is shown in the last column in terms of the per cent of adequacy of the existing structure. As an illustration, the 12-foot South Harlem sewer at Kingshighway has 40 per cent of the capacity required to accommodate the 20-year flood flow.

In inspection of the figures in the percentage column indicates that one of the more recently constructed systems in the County, Maria Creek, has a very high percentage of adequacy. An examination has been made of the trunk sewers in the Pine Lawn District which, together with the Maria Creek sewers, discharge into the 12-foot Harlem Creek sewer at the city limits. The downstream section of this system is an 84-inch sewer which would seem to be adequate for a 5 or 10-year frequency design. It would need minor relief to meet the 20-year standard. The same situation is nearly true of the 72-inch sewer next upstream. The third section, a 60-inch sewer, would be nearly adequate if the area south of Natural Bridge Road is eventually given a main sewer outlet directly east into the 84-inch trunk line. Except for these districts, other sewers investigated have capacities generally from 40 to 60 per cent of the requirement. The percentage figure may be interpreted in a different way, understanding that, in general, the flood flow to be expected once in five years is on the order of 70 to 75 per cent

of the 20-year flood, and the flood flow to be expected on the average annually is from 45 to 50 per cent of the 20-year flood. Applying this relationship to the percentage figures in the table, (it would appear that many sections of the trunk sewers would be expected to be overcharged on the average once in two or three years. Certain critical sections do not have sufficient capacity to accommodate the flood flow to be expected on the average once a year. The most deficient sections would appear to be the South Harlem sewer extending from about Kingshighway to a point above Union Avenue where overcharge and flood damage would seem to be probable more often than once a year. A similar finding would apply to the sewers in both City and County on the South Baden System adjacent to the Small Arms Plant and also to the outlet section of the main Baden sewer. In the latter case, a bottleneck condition at the outlet such as this might well react and cause flooding and damage at considerable distances upstream, and even where, for the upstream sections themselves, a somewhat higher percentage of adequacy is shown.

It is interesting to speculate on the circumstances that have developed to produce this deficiency of storm drainage capacity.

The first of these is that standards of drainage for urban areas are higher than those considered acceptable, say 50 years ago. This undoubtedly is a reaction from the general increase in urban property value itself. It is also recognized that up to the last 20 or 30 years there was little adequate basic data with respect to rainfall occurrence, and the intensity of rainfall for a storm of any particular duration which might be expected with any particular frequency of occurrence was, to a considerable extent, a matter of opinion. There was an even greater lack of fundamental data with regard to the rates of runoff which might be produced by a rainfall of a

particular intensity. In the absence of positive factual information which would justify relatively high capacities for new sewers, and with the common scarcity of funds for public work of this kind, it would seem obvious that underdesign would commonly occur.

Separate from the above, it is known that during the period of from 20 to 40 years ago, when these trunk sewers were constructed, there was no conception that the outlying areas of both City and County would be developed and occupied to anywhere near the density which has actually occurred. It was not expected that, even within the City, the newer residential areas would have anything like 50 per cent of impervious surface which today is a fair average. In the period of 1910-20, nearly all of the County area was rural in character, and in the design of the trunk sewers within the City, runoff quantities from the County area were based on an expectancy of continued farming of these areas or at the most of a suburban development of low density. At the present time much of this County area east of Lucas and Hunt Road has developed to a degree of imperviousness approaching that east of the city limits.

Undoubtedly, all of these factors are in the background of the present situation, of a trunk sewer system having a capacity of about one-half of what it should be.

For those drainage systems having a large part of their service area in St. Louis County, the development of the County area from rural to relatively dense urban condition is undoubtedly the biggest factor in producing the present overcharge. This development, as compared to rural conditions, has acted to increase runoff rates in two ways: first, through the much greater extent of impervious surface; and second, through the fact that improved water courses are acting to concentrate the water at the lower end of the

system in a much shorter time than would have been the case under natural conditions. As an example of the effect of the water course improvement, the North Baden-Jennings area is conspicuous. In the original design of the Baden public sewer, the time of water flow from the head water at the city limits was calculated as 53 minutes. From the present study, on the basis of storm sewers already provided and those for which plans have been made, the time of flow is taken as 29 minutes. This means that this system requires capacity for the shorter and much more intense 30-minute storms, as compared to the lighter rainfall related to storms of more than an hour's duration. For situations such as this, probably one-third of the present inadequacy can be related to the high degree of imperviousness which has developed, and another one-third to the shortening of the time of concentration. The remaining deficiency is chargeable to higher standards of flood protection.

Section 6 - Suggested Plan of Relief Sewer for the Harlem-Baden System

From the tables in Appendix II-A, it was possible to see the amount of overcharge of each section of each trunk sewer and to determine the flow quantity which must be diverted upstream therefrom to leave the flow and capacity in satisfactory balance. The study of these figures developed the fact that such diversions would need to be made for each of the four trunk sewers at points somewhat east of the St. Louis city limits, and other diversions in St. Louis County.

Experience has shown that the cost of providing new large storm sewers in the fully developed urban area becomes tremendous if such sewers are to be constructed in open-cut through city streets. The only economical method of providing such relief sewers is through the construction of tunnels requiring disturbance of the surface only at the shaft locations. When relief

sewers are to be provided by tunnels, these may be routed in as direct a route as possible from the points of divergence to the Mississippi River.

For this system, it would appear that a desirable route is that shown on Fig. II-1, extending northwardly from Clara and Ashland Avenues, passing the points of diversion on each of the other three branches, and discharging into the Mississippi River opposite the Baden Pumping Station. The relief sewer plan has been developed along this line, and with the diversion to it from the existing trunk systems at the points indicated, these systems would all be adequate throughout their lengths below the points of diversion, as shown in the "After Relief" Tables II-A-6 and II-A-7 in Appendix II-A.

For two of the trunk sewers, the North and South Baden, considerable lengths of overcharged sewers still exist upstream from these diversion points, and the curing of this situation requires the provision of the branch relief tunnels indicated in plan on Fig. II-1. On the South Harlem sewer above the point of diversion, the lowering of the hydraulic grade at the diversion will increase the capacity from 1,450 cfs to about 1,750 cfs; a small lateral relief sewer will be required for a part of its length.

On the profile in Fig. II-1, the elevations of the existing sewers at the points of diversion are shown, and it is found feasible to develop a very satisfactory hydraulic grade through or below these elevations to the Mississippi River.

Table II-A-8 of Appendix II-A develops the flow quantities and required sizes of the proposed trunk relief sewers.

A preliminary estimate of cost of this relief sewer project is given in Table II-2. This estimate presents separately the cost of the main trunk relief tunnel and of the two branch sewers extending westwardly into

St. Louis County. Construction of the main relief sewer tunnel is now urgently needed. After it is constructed, it will develop also considerable relief to areas along the lines of the proposed branch sewers. The construction of these branches might be treated as a second stage and deferred for a time until all of the tributary area in St. Louis County has been fully developed.

TABLE II-1-A

HARLEM-BADEN SYSTEMS
FLOW, CAPACITY, AND INADEQUACY
EXISTING TRUNK SEWERS

Maria Creek-South Harlem

	<u>Size</u>	<u>"Q"</u>	<u>Capacity</u>	<u>Per Cent Adequate</u>
<u>In County</u>				
	54"	270	220	80
	84"	740	600	80
	108"	970	1,050	106
<u>In City</u>				
Above Clara	12' HS	2,050	1,450	70
Above Union	12' "	2,950	1,300	45
Above Kingshighway	12' "	3,600	1,450	40
	14' "	4,000	2,200	55
Above Florissant	16' "	5,400	3,100	55
<u>North Harlem</u>				
	7½'	780	600	80
	11' HS	1,500	900	60
	12' "	2,200	1,450	65
<u>Main Harlem Sewer</u>				
	25' HS	8,500	5,700	65
	29' "	9,400	7,700	80

TABLE II-1-B

HARLEM-BADEN SYSTEMS
FLOW, CAPACITY, AND INADEQUACY
EXISTING TRUNK SEWERS

Melrose-South Baden

	<u>Size</u>	<u>"Q"</u>	<u>Capacity</u>	<u>Per Cent Adequate</u>
<u>In County</u>	108"	1,800	1,020	55
	9' HS	2,100	750	35
<u>In City</u>	10' HS	2,500	1,050	40
	12' "	3,000	1,450	50
	14' "	3,800	2,150	55

Jennings-North Baden

<u>In County</u>				
(Proposed)	10' HS	2,600	1,050	40
	11' "	3,050	1,450	50
<u>In City</u>		4,300	1,900	45

Main Baden Sewer

	18' HS	8,000	3,150	40
	23' "	8,500	3,550	40

TABLE II-2

ESTIMATE OF QUANTITIES FOR PROPOSED RELIEF TUNNEL
AND BRANCH RELIEF TUNNELS FOR HARLEM & BADEN WATERSHEDS

<u>Line</u>	<u>Length</u>		<u>Yds.³/Ft.</u>	<u>Yds.³</u>	<u>\$/Yd.³</u>	<u>Cost</u>
<u>MAIN RELIEF TUNNEL</u>						
25' H.S.	4,000	Earth Excavation	35.0	140,000	\$ 5.00	\$ 700,000
		Reinforced Concrete	5.20	20,800	60.00	1,248,000
21½' x 21½' H.S.T.	3,550	Rock Excavation	18.05	64,076	20.00	1,281,520
		Concrete Lining	2.93	10,402	50.00	520,100
19½' x 19½' H.S.T.	2,150	Rock Excavation	15.15	32,572	20.00	651,440
		Concrete Lining	2.74	5,891	50.00	294,550
18' x 18' H.S.T.	5,150	Rock Excavation	13.10	67,465	20.00	1,349,300
		Concrete Lining	2.50	12,875	50.00	643,750
14½' x 14½' H.S.T.	3,900	Rock Excavation	8.85	34,515	20.00	690,300
		Concrete Lining	2.04	7,956	50.00	397,800
14' x 14' H.S.T.	2,800	Rock Excavation	8.33	23,324	20.00	466,480
		Concrete Lining	1.97	5,516	50.00	275,800
13½' x 13½' H.S.T.	1,900	Rock Excavation	7.83	14,877	20.00	297,540
		Concrete Lining	1.89	3,591	50.00	179,550
<u>LATERAL NO. 1 - BRANCH RELIEF TUNNEL</u>				Sub-Total. . \$8,996,130		
10' x 10' H.S.T.	1,900	Rock Excavation	4.65	8,835	\$20.00	\$ 176,700
		Concrete Lining	1.44	2,736	50.00	136,800
10½' x 10½' H.S.T.	7,600	Rock Excavation	5.06	38,456	20.00	769,120
		Concrete Lining	1.51	11,476	50.00	573,800
<u>LATERAL NO. 2 - BRANCH RELIEF TUNNEL</u>				Sub-Total. . \$1,656,420		
8½' x 8½' H.S.T.	3,700	Rock Excavation	3.56	13,172	\$20.00	\$ 263,440
		Concrete Lining	1.23	4,551	50.00	227,550
				Sub-Total. . \$ 490,990		
				Total. . . . \$11,143,540		
With contingencies, engineering and administration						\$13,500,000

Section 7 - Storm Drainage of the River Des Peres-Deer Creek Valley

This is the second subdivision of the St. Louis Country drainage system in which the outlet service is through facilities of the City of St. Louis. On Fig. 1 there has been endorsed a watershed line of this drainage system, and also the principal artificial drainage facilities and the natural water courses serving as such. In general, the River Des Peres rises near Olive Street and Warson Roads, and flows eastwardly passing through University City into the City of St. Louis just west of the Delmar Railroad Station. It makes a long loop eastward through St. Louis, and at the end of the westward reach is joined with Deer Creek in the vicinity of Lindenwood. The main stream continues to the Mississippi River at the southern limits of the City of St. Louis.

The City of St. Louis has installed improved storm drainage facilities along the routes of the natural water courses within its area. These consist of the large paved open channel from the Deer Creek-River Des Peres junction at Lindenwood to the Mississippi River; a somewhat smaller open channel from Lindenwood eastwardly to a point near Kingshighway, and very large closed sewers extending from that point to the University City limits.

University City has constructed an extension of the closed sewers from the city limits to Harvard Avenue, and has now under consideration the installation of improvements along the course of the River Des Peres out to its western limits.

In the Deer Creek Valley, no improvements have been installed along the course of the main creek. Since the construction of the improved facilities in St. Louis there has been some bank and bed erosion along the lower reaches of Deer Creek, and the capacity of the original channels has been somewhat increased thereby. To a small extent, this will probably reduce the frequency of flooding in the lower areas between Brentwood, Maplewood and Webster Groves.

One of the largest tributaries of Deer Creek is Black Creek which originates in University City near Delmar Avenue and Price Road, and goes through Ladue, Clayton, Richmond Heights, Brentwood, and Maplewood to a junction with Deer Creek. The only improvements along this branch are those constructed by the City of Richmond Heights. These improvements consist of the installation of paved channels along the main Black Creek and two of its forks.

Except for the improvements on Black Creek above mentioned, the trunk storm drainage for the whole Deer Creek Valley is still furnished by the original natural water courses. With the general urban development in the area extending as far out and even beyond Lindbergh Boulevard, floods in these creeks have been increasing in frequency and in damaging intensity.

Section 8 - Proposed Plan (Deer Creek)

It is obvious that the provision of improved storm drainage for the main Deer Creek and its principal branches must take the form of enlargement and deepening of existing channels, since the cost of enclosing these creeks would be many times the value of benefits that would result therefrom. Consideration has been given to two types of channel improvements: (a) relatively large and wide channels in general without bed or bank pavement; and (b) somewhat smaller channels which might be achieved by the installation of relatively smooth paving.

Channel paving under type (b) introduces large items of cost, and since the land along the creeks is now subject to frequent flooding, and is consequently not of high value, the reduction in channel width would produce only a small off-setting reduction in cost. For the purpose of this study, it has been assumed the storm drainage improvements would consist of unpaved channels with relatively flat side slopes. It is recognized that such channels would be subject to considerable erosion in connection with the larger floods and would require continuous maintenance. However, it is believed that such channels would be the more economical solution, and the first cost of the project more likely to be within the capability of the area to finance.

There is a second factor which points importantly at the same conclusion. This results from the fact that the smaller paved channels would operate at much higher velocities of flow than the unpaved channels. The effect would be to shorten the time of concentration of flood waters in the lower portion of the Deer Creek Valley and in the St. Louis facilities. With this shorter time of concentration, critical floods would be related to storms of shorter duration and higher intensity, and the general effect of installing such a system might well be to create a serious overcharge of the existing facilities

within the City of St. Louis. Since the expense of enlarging the City's main River Des Peres channel would be very great, this situation should certainly be avoided if possible. This phase is discussed in a later section of this report.

Along all of the branches of Deer Creek and along the main valley up to about Lindbergh Boulevard, there has been appreciable occupancy of the lowlands. Also, these lowlands are crossed by main thoroughfares, the flooding of which creates a serious interruption to community activities and, in some instances, a possible hazard to life.

West of Lindbergh Boulevard the lowlands have not been appreciably occupied, and there is reason to believe that the existing creeks can be maintained and permitted to flood without a serious economic disadvantage.

For the purpose of this preliminary report, Deer Creek and its principal branches are assumed to be the continuing storm drainage facilities for the valley, and their improvement, including the main creek up as far as Lindbergh Boulevard, constitutes the master plan of storm drainage.

The two major branches of Deer Creek are the Black Creek and the Two-Mile Creek. These are included within the plan up to a point where they drain approximately one square mile. Two additional branches, the Shady Creek running through northern Webster Groves and the Glendale-Rock Hill Branch, are also of sufficient size and importance to be included in the plan.

The location and type of improvement for the main Deer Creek is shown in plan and profile on Figs. II-2 and II-3. As indicated on these sheets, the floodway improvement of the main creeks involves the cutting off of some of the sharper bends and the widening, and to some extent deepening, of the channel to give the carrying capacity for the ten-year frequency floods. On the profile portion of these sheets there is shown the hydraulic gradient which, in general, would represent the water surface in the channel during

the passage of the ten-year flood. This gradient, in general, lies slightly below the level of the adjacent bottom lands. On this profile is also shown the flow line or bottom of the improved channel, and as readily seen this involves a slightly greater depth than the present creek at some points. The shape and width of the proposed improved channels are indicated. In determining these dimensions the effort was made to avoid any considerable lowering of the creek bed as it is known that this would be likely to require rock excavation at a number of points. Because of the avoidance of increased depth, it is necessary to give the new floodway channels considerable width. Throughout the greater part of the project, this can be accomplished without disturbance of adjacent improvements.

A reconnaissance survey was made of all existing bridges. Where these bridges are nearly adequate to carry the design flood efficiently, a water surface drop was allowed in the hydraulic gradient to make their use satisfactory. In other cases existing water ways were either so inadequate or the structures so antiquated as to require inclusion in the project of a new bridge structure as an element thereof.

Along the lower reaches, primarily below Black Creek, it was found that the construction of the wide, unpaved channel would be unfeasible, both because of the great width and because of the low channel velocities which involved great head losses at certain of the existing bridges. To this section a smaller, paved channel has been provided, and with the higher velocities it is found possible to utilize several bridges which would otherwise have to be replaced. (See Fig. II-4 for Black Creek suggested improvement.)

A somewhat similar situation exists on Shady Creek below Gore Avenue, where narrower, paved channels appear to be required.

The engineering investigations resulting in the preliminary design of floodway improvements are described in more detail in Appendix "B".

In summary the proposed floodway improvement of the Deer Creek Valley involves the following elements:

1. The acquisition of overflow bottom land along the main creek west of Lindbergh Boulevard and their preservation as natural floodways without any material enlargement of the waterways.

2. The construction of improved floodway channels along the main Deer Creek from Lindbergh Boulevard to the St. Louis City Limits, a distance of about 36,000 feet.

3. Construction of similar improved channels along the Black Creek, Two-Mile Creek, Shady Creek and Glendale-Rock Hill Creek for a total length of about 55,000 feet.

4. The construction of new bridges where necessary and the improvement of the waterway through other bridges.

In Table II-3 there is presented the estimated cost of this construction. In that table the estimated area of 250 acres of land required for channel easements east of Lindbergh Boulevard provides width of the channels themselves and for service roadway. In many sections it may be found desirable to acquire also considerable areas of adjacent low-lying lands, the elevation of which can be increased considerably by filling with spoil from the channels. In some instances these additional lands would be valuable as the routes of the parkways and in others could be used for playgrounds.

An additional acreage of land indicated, as west of Lindbergh Boulevard, involves generally the full width of the flood plain. This may be required only as an easement to permit some clearing out of brush and control against obstructions or the placing of improvements in floodable areas. Except for these matters, most of this property could be left available for the use of the original owners.

TABLE II-3

ESTIMATE OF COST

DEER CREEK

Item of Work	Quantity	Unit	Unit Price	Amount
MAIN CREEK				
1. Channel Excavation, Lindbergh Blvd. to River Des Peres (36,920 ft.)	1,132,000	cu.yd.	\$ 0.80	\$ 905,600.00
2. Rock Excavation, Lindbergh Blvd. to River Des Peres (36,920 ft.)	20,000	cu.yd.	10.00	200,000.00
3. Concrete Channel Paving, Missouri Pacific Bridge (Station 71+00) to River Des Peres	86,000	sq.yd.	7.00	602,000.00
4. New Bridge, Rock Hill Road			Lump Sum	50,000.00
5. New Bridge, North and South Road			Lump Sum	103,000.00
6. New Bridge (between Laclede Station Road and North and South Road)			Lump Sum	42,000.00
7. Concrete Paving under and adjacent to five bridges	5,000	sq.yd.	10.00	50,000.00
BRANCHES				
8. Two-Mile Creek	16,300	lin.ft.	9.00	146,700.00
9. Shady Creek (unpaved channel)	6,300	lin.ft.	4.20	26,460.00
10. Shady Creek (paved channel)	5,700	lin.ft.	35.00	199,500.00
11. Glandale	2,900	lin.ft.	7.00	20,300.00
12. Black Creek (unpaved channel)	8,775	lin.ft.	14.00	122,850.00
13. Black Creek (paved channel)	6,680	lin.ft.	27.00	180,360.00
14. East Fork Branch of Black Creek	4,800	lin.ft.	18.00	86,400.00
15. Country Club Branch of Black Creek	3,130	lin.ft.	26.00	81,380.00
16. Bridges			Lump Sum	148,000.00
17. Concrete Paving under and adjacent to six bridges	3,000	sq.yd.	10.00	30,000.00
RIGHT-OF-WAY				
18. East of Lindbergh Blvd.	250	acre	200.00	50,000.00
19. West of Lindbergh Blvd.	300	acre	100.00	30,000.00

\$3,074,550.00

With contingencies, engineering, and administration (20%)

\$3,700,000.00

Section 9 - Proposed Plan West Fork of River Des Peres

As stated in an earlier section, the City of St. Louis has enclosed this stream in a larger sewer up to the University City limits, and the City of University City has extended this improvement as far as Harvard Avenue. Along the main stream, west of Harvard Avenue and on the north-east branch, some channel straightening and paving has been installed.

Some years ago a preliminary plan was worked out for the provision of improved channels as far out as the western limits of University City. At the present time this matter is being entirely restudied by the present Consultants, and construction plans will be available within the next year. In view of this situation, no new preliminary studies have been made in connection with the present report to the Bi-State Agency; instead, the earlier studies have been given a quick review and have been embodied in the design table included in Appendix "B". It is probable that through most of University City the development of adjacent property is so far advanced as to make it infeasible to lay out wide, unpaved storm channels. The construction, therefore, will probably involve somewhat narrower channels with concrete paving. For the purpose of this report a rough estimate of cost has been prepared and is shown in Table II-4.

West of University City limits the existing creek channels are somewhat more nearly adequate. As in the case of Deer Creek, this proposed plan includes the taking of easements along the Creek bottom lands for about three miles west of the University City limits. In this section there will be a moderate clearing out of brush and sufficient control to prevent the development of any new restrictions to flow. The plan also includes the provisions for channel improvement on certain of the branches as indicated on Table II-4.

TABLE II-4

ESTIMATE OF COST
West Fork River Des Peres Channel Improvement

Item of Work	Quantity	Unit	Unit Price	Amount
<u>MAIN CREEK:</u>				
1. Clearing and cleaning out channel west of Term. R.R.	15,000	lin.ft.	\$ 3.00	\$ 45,000.00
2. Channel excavation, Harvard Ave. to Term. R.R. (17,000')	260,000	cu.yd.	2.00	520,000.00
3. Rock Excavation, Harvard Ave. to Term. R.R.	20,000	cu.yd.	8.00	160,000.00
4. Concrete channel paving	140,000	sq.yd.	10.00	1,400,000.00
5. Bridges		Lump Sum		250,000.00
<u>BRANCHES:</u>				
6. N.E. Branch-Term. R.R. (partly improved)	7,500	lin.ft.	17.00	127,500.00
7. N.W. Branch	5,000	lin.ft.	10.00	50,000.00
8. Olivette Branch-Price Rd.	6,200	lin.ft.	12.50	77,500.00
9. Bridges and culverts		Lump Sum		125,000.00
<u>RIGHT-OF-WAY:</u>				
10.	100	acre	300.00	30,000.00
11.	200	acre	150.00	30,000.00
				<u>\$2,815,000.00</u>
With contingencies, engineering and administration (20%)				\$3,350,000.00

Section 10 - Storm Drainage Improvement in the Maline Creek Valley

The Maline Creek watershed is shown in outline on Fig. 1 where it will be seen as the principal drainage area in the northern part of the county. The creek rises in Overland and flows generally eastwardly through Ferguson to the Mississippi River, the last downstream half mile crossing through the narrow northern tongue of the City of St. Louis.

In this downstream half-mile the City of St. Louis has constructed a large and much deepened improved floodway channel which, also within the city, is crossed by five bridges.

Preliminary comparisons were made of ten-year flood flows and the existing creek channel capacities with a finding that the existing creeks above Ferguson, and slightly within that city would be capable of carrying these flood flows without appreciable channel enlargement, although the cutting of brush and the removal of some obstructions will be required. Because of this situation, the plan provides for the taking of easements along the creek from the forks above Natural Bridge Road to about Cuniff Avenue in Ferguson, a distance of 15,000 feet.

Below that point the main stream takes on a more alluvial character, gradients are materially flatter and the existing creek much more crooked. This situation requires improved and enlarged channels throughout. On Figs. II-5 and II-6 the location and character of the channel improvements on the main stream are indicated. It will be noted from these sheets that the spillway constructed by the City of St. Louis at the St. Louis limits provides a rise in the creek bed at that point of over ten feet. To secure adequate capacity this spillway must be removed and a considerable amount of channel deepening undertaken as far up as about Hall's-Ferry Road. Above that point the improvement involves generally straightening and enlargement but very little deepening.

A reconnaissance survey of the bridges indicates that the existing bridges at Bellefontaine Road and at Hall's-Ferry Road are entirely inadequate in waterway and the plan includes new bridges at both locations. It was found that other bridges could be continued in service with provision for clearing out, deepening and widening the waterways under them, and installing channel paving for some distance in the immediate vicinity.

In addition to the improvement to the main creek, the plan provides for the improvement of the Hall's-Ferry (Blackjack) Branch up to Highway 77 and of one of its branches for a short distance. It also includes the improvement of two branches in Ferguson for a length of something less than a mile each. The estimated cost of improvements is shown in Table II-5.

Section 11 - Gravois Creek

As shown on Fig. 1, Gravois Creek is the southern-most of the large watersheds lying west of the City of St. Louis. The stream enters the City of St. Louis at its southern limits about a mile and a half west of the Mississippi River. It has its outlet to the Mississippi River through the large paved floodway channel which the City has constructed.

As in the case of the other large watersheds, the normal type of flood flow improvement will consist of wide, straightened and unpaved channels, with paved sections introduced only where the area is seriously contracted or where their use will avoid expensive bridge reconstruction.

The proposed improvement is shown in plan and profile on Figs. II-7, II-8, and II-9. At its outlet end into the River Des Peres channel, the existing stream crosses a high rock ledge. This will have to be lowered considerably in order to keep the floods off of the flood plain along the lower mile of the creek. As shown in Fig. II-6, the hydraulic grade will

TABLE II-5

ESTIMATE OF COST
Maline Creek Channel Improvement

Item of Work	Quantity	Unit	Unit Price	Amount
<u>MAIN CREEK:</u>				
1. Clearing and cleaning out channel above Cuniff Ave.	15,000	lin.ft.	\$ 3.00	\$ 45,000.00
2. Channel excavation, Cuniff Ave. to City Limits (29,000')	900,000	cu.yd.	0.80	720,000.00
3. Rock excavation	10,000	cu.yd.	8.00	80,000.00
4. New bridges - Bellefontaine Road			Lump Sum	85,000.00
5. New bridges - Hall's Ferry Road				60,000.00
6. Concrete paving under and adjacent to 5 bridges	8,000	sq.yd.	10.00	80,000.00
<u>BRANCHES:</u>				
7. Hall's Ferry Branch, south of Highway #77	17,000	lin.ft.	Lump Sum	175,000.00
8. North Branch, Ferguson	4,000	lin.ft.	Lump Sum	20,000.00
9. South Branch, Ferguson	4,500	lin.ft.	Lump Sum	25,000.00
10. Bridges and culverts and paving			Lump Sum	35,000.00
<u>RIGHT OF WAY:</u>				
11.	200	acre	200.00	40,000.00
				\$1,365,000.00
With contingencies, engineering and administration (20%)				\$1,575,000.00

still have about a seven-foot drop in the downstream thousand feet. Upstream from this section, however, relatively little creek deepening is required, the only important section being in the vicinity of and east of Union Road, and elsewhere there is generally ample width for adequately wide channels. A principal example of contracted area is that through the upper portion of the Portland Cement Plant west of Union Road, and here for a short section a narrow and deeper channel with paved sides is introduced.

Gravois Creek proper has its upstream beginning point at the forks immediately above Highway 66. At these forks the long branch is that extending from the north through the Westborough Country Club, and then west out of Kirkwood. As shown in the design table in Appendix B, Table II-B-4, the flow through this northward branch has been used to determine the critical time of concentration along the main creek. Also, a portion of the channel along this branch up to the Missouri Pacific Railroad at about Station 524 is included in the main project, and is covered in the primary estimate of cost. The west fork above Highway 66, coming down out of the central Kirkwood business district, is listed as one of the main branches included in the project, and appears in the estimate as such.

The stream is crossed by a number of highway and railroad bridges, the present waterways of which vary from entirely adequate to entirely inadequate. Where the waterways are nearly adequate, it has been found possible to utilize the existing bridges by adjusting the hydraulic grades to permit some head loss at these points. These are indicated from inspection of the hydraulic grades on the profile sheets. Other bridges are listed in the estimate table for completely new structures. Two of the older existing bridges can apparently be abandoned; that at the Old Tesson Ferry Road where

services are available separately to each side of the stream, and that at the upper Green Park Road, where it is proposed that the project include a new access road to Union Road along the south side of the project.

Included in the main project are five of the branch creeks as listed in the estimate table. The longest of these is the Kirkwood Branch, or west fork, above Highway 66 from the Frisco Railroad crossing down to the junction. The five branches selected for inclusion are extended upstream to a point where their drainage areas are from 600 to 800 acres. The total length of the branches is approximately 32,000 feet; the length along the main stream, including the north part above referred to, is approximately 52,000 feet, the whole involving floodway improvement having a length of about 16 miles. An approximate estimate of cost of the project is shown in Table II-6

TABLE II-6

ESTIMATE OF COST

GRAVOIS CREEK CHANNEL IMPROVEMENT

Item of Work	Quantity	Unit	Unit Price	Amount
MAIN CREEK				
1. Channel Excavation, Missouri Pacific RR to River Des Peres (52,400 ft.)	1,770,000	cu.yd.	\$ 0.80	\$1,416,000.00
2. Rock Excavation	36,000	cu.yd.	8.00	288,000.00
3. Concrete Channel Paving (1,300 ft.)	4,000	sq.yd.	7.00	28,000.00
4. New Bridge - Lower Green Park Road			Lump Sum	25,000.00
5. New Bridge - Union Road			Lump Sum	71,500.00
6. New Bridge - Grant Farm, Private			Lump Sum	14,500.00
7. New Bridge - Pardoe Road			Lump Sum	33,000.00
8. New Bridge - Private Road			Lump Sum	15,500.00
9. Additional Waterway - Missouri Pacific RR			Lump Sum	51,000.00
10. New Bridge - Big Bond Road			Lump Sum	21,000.00
11. New Double Box Culvert, Frisco RR			Lump Sum	100,000.00
12. Additional Bridge Adjustment, Tesson Ferry & Bayless			Lump Sum	45,000.00
13. Concrete Paving under and adjacent to six bridges	15,000	sq.yd.	8.00	120,000.00
BRANCHES				
1. Kirkwood	9,500	ft.	7.00	66,500.00
2. Buckley Road	4,000	ft.	5.00	20,000.00
3. Sappington	7,500	ft.	6.00	45,000.00
4. Mulberry Creek	6,500	ft.	6.00	39,000.00
5. Afton	5,000	ft.	6.00	30,000.00
6. New and Adjustments to Existing Bridges			Lump Sum	90,000.00
7. Concrete Paving under and adjacent to six bridges	7,000	sq.yd.	8.00	56,000.00
RIGHT-OF-WAY				
1. Main Creek	200	acre	200.00	40,000.00
2. Branches	100	acre	200.00	20,000.00
				<u>\$2,635,000.00</u>
With contingencies, engineering and administration (20%)				\$3,162,000.00

Section 12 - Coldwater Creek

In order to present a complete approximate total of cost for the ultimate storm water improvements necessary in the St. Louis metropolitan area in Missouri, we have also briefly analyzed the present conditions in the Coldwater Creek watershed. Over 20 years ago a Coldwater Drainage District was incorporated, and at present the trustees for this district are the three members of the St. Louis County Court. The necessary right-of-way for a straightened channel was obtained, and some actual construction consisting of eliminating bad bends in the natural creek was carried out. The detailed construction plans for the work performed by this drainage district are not available as the files of the County Court contain only a general assessment map. The engineer who prepared the plans and supervised this construction is now deceased, and efforts to locate the detailed construction plans have failed.

The rapidly increasing development with small homes on small city lots, which has occurred on the upper reaches of Coldwater Creek southwardly from Natural Bridge Road, has tremendously increased the storm water runoff. The present enclosure in Lambert-St. Louis Municipal Airport is inadequate for floods of relatively low frequencies. Continued development of the area upstream from the airport will further aggravate the inadequacy of the present closed section through the airport, and will make necessary, in the not too distant future, the supplementing of these facilities in order to prevent relatively frequent closing of the airport due to flooding. Below the airport the present culvert under the Wabash Railroad creates a serious restriction and must be relieved.

Downstream from the Wabash Railroad, the present channel will require some deepening and material widening in order to be adequate for the flood flows from a 10-year frequency rainfall. Such additional channel capacity will be required to at least the vicinity of the City of Florissant. Below

Florissant it is estimated that the improvements will be sparse, and that some flooding of the valley proper could occur without serious damage.

On the assumption that the extreme upper reaches to the south of St. Charles Rock Road, up to the point where a 60-inch circular sewer will be required to be enclosed, and on the basis of a paved channel because of restricted width due to the encroachment of developed property between St. Charles Rock Road and a point approximately half-way to Natural Bridge Road, and improved unpaved channel to the airport with a relief closed sewer consisting of a triple box through the airport and under the Wabash Railroad, and widened, deepened and improved channel between the Wabash R.R. and Florissant Avenue, it is estimated that the total construction cost will amount to approximately 5 million dollars. Of this sum, the work within the airport is estimated to cost approximately 3 million dollars. The present assessed valuation of Coldwater Creek is approximately 50 million dollars.

Section 13 - Watkins Creek

An analysis of the present capacities of the natural Watkins Creek channel, as well as the principal highway and railroad crossings, indicates that no improvements will be necessary in this watershed provided encroachment on the channel is not permitted. Maintenance of the present channel, free from obstructions and clear of brush and growth, will produce a channel adequate for the estimated storm water runoff from this watershed.

APPENDIX II-A

DETAILED ANALYSIS OF RELIEF SEWERS FOR THE HARLEM AND BADEN SYSTEMS

APPENDIX II-A

DETAILED ANALYSIS OF RELIEF SEWERS FOR THE HARLEM AND BADEN SYSTEMS

For the purpose of this analysis, the trunk sewers of these two systems have been shown in somewhat greater detail on Figs. II-A-1 and II-A-2. On these diagrams, the trunk sewers are also shown in profile, and hydraulic grades have been drawn on which would seem to be representative of satisfactory operating conditions. The capacity of each section of each of the trunk sewers has been determined on the basis of the sizes indicated and of these hydraulic grades.

Analysis of the sewer system has been carried out by an application of the Rational Method using the runoff rates (P.I.) developed by the City of St. Louis for 20-year frequency storms. The particular rates selected are based on an understanding that, within the City of St. Louis, the development of the area has produced a surface condition of about 50 per cent impervious. In the adjacent St. Louis County areas, a corresponding figure of 40 per cent would seem to be a satisfactory average. However, in the extreme western portion of the Baden watersheds, that is, generally west of Lucas and Hunt Road, a lighter type development was assumed having a percentage of imperviousness of 30. For the parks and cemeteries, the percentage of imperviousness is taken at 10.

For each of the trunk sewers, an analytical table has been prepared, the first of these being Table II-A-1 covering the Maria Creek and South Harlem Systems. An examination of this table will show that the time of concentration has been carried forward from section to section based on lengths of

sewers upstream and the calculated velocities through them. For each section having the particular time of concentration, the corresponding P.I. value for the 20-year storm is listed, and the calculated flow is the product of the tributary acreage and the P.I. value. The last column of the table shows the excess of calculated flow over the capacity of the existing sewer. A similar analysis of the existing North Harlem sewer is presented in Table II-A-2, and for the lower section of the Harlem Creek system in Table II-A-3. The data for the North and South Baden Systems are shown in Tables II-A-4 and II-A-5, respectively.

Subsequent to the design of the trunk relief sewers, Tables II-A-6 and II-A-7 were prepared as a check on the propriety of the relief design. These tables show the corresponding flow in the trunk sewers after relief comparable to the capacity of the sewers and indicate a satisfactory balance of quantities.

Table II-A-8 is the design table for the trunk relief sewer itself. It has been prepared by a similar application of the Rational Method, carrying forward the calculated time of concentration from the sewers which are cut to and through the trunk sewers themselves.

Comparing Table II-A-7, that is, the North Baden sewer after relief, and Table II-A-8, the relief sewer itself, it will be seen that the relief provides for the splitting out of part of the flow of the North Baden sewer at Kingshighway NW and North Point Avenue. In order to reconcile the two tables, this diverted flow has been translated into fictitious values of proportionate acreage. This is necessary since the time of concentration at the North Baden sewer after relief and the time of concentration in the relief sewer at the diversion point are different.

TABLE II-A-1

PRELIMINARY COMPUTATIONS OF CAPACITIES AND PRESENT FLOW TRIBUTARY
TO MARIA CREEK - SOUTH HARLEM SEWER SYSTEMS
ON BASIS OF 20-YEAR RAINFALL

n = .013

Park and Cemetery Property - 10% Impervious
County Developed Area - 40% Impervious
City Developed Area - 50% Impervious

Line	Length	Slope	Cap. c.f.s.	Vel. f.s.	t min.	T 10 min.	A Acres	P.I.	Q c.f.s.	Excess Q c.f.s.
12", 24", 30"	1,860	.018	(30") 56	11	3	13	38	2.50	95	40
42"	1,220	.014	120	12	1.7	14.7	78	2.50	195	75
48"	510	.013	165	13	0.7	15.4	92	2.50	230	65
54"	895	.013	220	14	1.1	16.5	108	2.50	270	50
60"	570	.013	300	15	0.7	17.2	128	2.50	320	20
84" Above Creek	1,471	.0089	600	16	1.8	19	295	2.50	740	140
84" Below Creek	320	.011	680	17.5	0.3	19.3	55(10%) 297(40%)	1.87 2.50	103) 742)	165
96"	560	.009	880	17	0.6	19.9	55(10%) 305(40%)	1.87 2.50	103) 762)	0
108"	880	.007	1,050	17	0.8	20.7	55(10%) 347(40%)	1.86 2.50	102) 868)	0

TABLE II-A-1

TABLE II-A-1 (Cont.)

Line	Length	Slope	Cap. c.f.s.	Vel. f.s.	t min.	T 10 min.	A Acres	P.I.	Q c.f.s.	Excess Q c.f.s.
12' H.S. Jct. above Clara	3,200	.005	1,450	14	3.8	24.5	55 (10%) 605 (40%) 195 (50%)	1.82 2.40 2.59	100) 1,450) 505)	755 2,055
12' H.S. above Belt	1,300	.004	1,300	14	1.6	26.1	55 (10%) 765 (40%) 363 (50%)	1.81 2.37 2.55	100) 1,810) 925)	1,535 2,835
12' H.S. above Union	1,700	.004	1,300	14	2	28.1	55 (10%) 765 (40%) 433 (50%)	1.79 2.32 2.50	99) 1,780) 1,081)	1,660 2,960
12' H.S. above Kingshighway	2,500	.005	1,450	15.5	2.7	30.8	55 (10%) 765 (40%) 721 (50%)	1.76 2.27 2.45	97) 1,740) 1,770)	2,157 3,607
14' H.S. above Marcus	2,920	.005	2,200	17	2.9	33.7	55 (10%) 765 (40%) 932 (50%)	1.74 2.23 2.40	96) 1,700) 2,240)	1,836 4,036
16' H.S. above Jct.	6,550	.005	3,100	19	5.8	39.5	55 (10%) 765 (40%) 1,604 (50%)	1.68 2.14 2.30	92) 1,640) 3,698)	2,330 5,430

TABLE II-A-2

PRELIMINARY COMPUTATIONS OF CAPACITIES AND PRESENT FLOW TRIBUTARY
TO NORTH HARLEM SEWER SYSTEM
ON BASIS OF 20-YEAR RAINFALL
(County Area Diverted to S. Baden)

n = .013

Park and Cemetery Property - 10% Impervious
County Developed Area - 40% Impervious
City Developed Area - 50% Impervious

Line	Length	Slope	Cap. c.f.s.	Vel. f.s.	t min.	T 10 min.	A Acres All 50% Imp except where noted.	P.I. except as shown	Q c.f.s.	Excess Q c.f.s.
Inlet Time Above 66"	3,200			10	5.3	15.3				
Lower End 44" x 66"	800	.008	180	11	1.2	16.5	105	2.69	282	102
Lower End 51"	720	.008	300	12	1.1	17.6	155	2.69	417	117
Lower End 7' - 7 1/2'	2,210	.006	600	13	2.8	20.4	290	2.68	777	177
Lower End H.S. 10'	3,560	.005	880	14	4.2	24.6	580	2.59	1,500	620
Lower End H.S. 12'	4,780	.005	1,450	16	5.0	29.6	50(10%) 865(50%)	1.78 2.47	89 2,140	2,229 779

TABLE II-A-2

TABLE II-A-3

PRELIMINARY COMPUTATIONS OF CAPACITIES AND PRESENT FLOW TRIBUTARY
TO COMBINED NORTH AND SOUTH HARLEM SEWER SYSTEMS
FROM W. FLORISSANT AVE. EAST
ON BASIS OF 20-YEAR RAINFALL

n = .013

Park and Cemetery Property - 10% Impervious
County Developed Area - 40% Impervious
City Developed Area - 50% Impervious

Line	Length	Slope	Cap. c.f.s.	Vel. f.s.	t min.	T min.	A Acres	P.I.	Q c.f.s.	Excess Q c.f.s.
Greater Harlem Time						39.5				
From South Harlem							55 (10%) 765 (40%) 1,604 (50%)			
From North Harlem							50 (10%) 865 (50%)			
Net Result from N. & S. Harlem at Upper End Spec- ial 25' H.S.						39.5	105 (10%) 765 (40%) 2,469 (50%)			
Lower End Special 25' H.S.	2,700	.0028	5,690	17.4	2.6	42.1	451 (10%) 765 (40%) 2,705 (50%)	1.66 2.10 2.26	750 1,610 6,100	2,770 8,460
Lower End Special 27' H.S.	1,450	.0028	6,450	17.95	1.4	43.5	451 (10%) 765 (40%) 2,705 (50%)	1.65 2.08 2.24	745 1,590 6,050	1,935 8,385
Lower End Special 29' H.S.	1,650	.0028	7,730	18.7	1.5	45.0	574 (10%) 765 (40%) 3,115 (50%)	1.63 2.06 2.21	935 1,575 6,870	1,650 9,380

TABLE II-A-3

TABLE II-A-4

Sheet 1 of 2

PRELIMINARY COMPUTATIONS OF CAPACITIES AND PRESENT FLOW TRIBUTARY
TO SOUTH BADEN SEWER SYSTEM FROM THE UPPER REACHES OF THE OPEN CHANNEL WEST
OF LUCAS & HUNT RD. TO RAVENWOOD AVE., END OF PRESENT CLOSED SEWER,
AND THROUGH CLOSED SEWER IN CITY AND COUNTY TO ITS JUNCTION WITH THE NORTH BADEN TRUNK
ON BASIS OF 20-YEAR RAINFALL

n = .030 for open channel
n = .012 for new sewers
n = .013 for present sewers

Park and Cemetery Property - 10% Impervious
County Developed Area - 30% Impervious above Lucas & Hunt Rd.
County Developed Area - 40% Impervious below Lucas & Hunt Rd.
City Developed Area - 50% Impervious

The following calculations assume open channel to remain to a point 2,100 feet west of the present closed sewer at Ravenwood Ave., the lower 2,100 feet to be enclosed in a new combined sewer adequate for both open channel and new closed sewer and adequate for runoff from 20-year rainfall. The balance of the computations are based upon the present sewer sizes and slopes.

Line	Length	Slope	Size	Vel. s.f.	t min.	T min.	A Acres	P.I.	Q c.f.s.	Cap.
Time of Concentration										
Above Sta. 82 - Lucas & Hunt Rd.	1,300	.035	39"	18.5	1.2	11.2	65 (30%)	2.28	148	
Above Sta. 57	2,500	.016	Open channel, 4'w bottom, 1:2 slopes, 3.5' depth	9	4.6	15.8	13.4 (10%) 64.9 (30%) 54.6 (40%)	1.87 2.28 2.50	) ) )	309
Above Sta. 39	1,800	.014	Open channel, 8'w bottom, 1:2 slopes, 5' depth	12.8	2.3	18.1	56.9 (10%) 122.6 (30%) 178.8 (40%)	1.87 2.28 2.50	) ) )	833
Above Sta. 18 - Ravenwood Ave.	2,100	.006	120"	16	2.2	20.3	59.3 (10%) 122.6 (30%) 331.3 (40%)	1.87 2.28 2.50	) ) )	1,218

TABLE II-A-4

TABLE II-A-4 (Cont.)

Sheet 2 of 2

<u>Line</u>	<u>Length</u>	<u>Slope</u>	<u>Size</u>	<u>Vel. s.f.</u>	<u>t min.</u>	<u>T min.</u>	<u>A Acres</u>	<u>P.I.</u>	<u>Q c.f.s.</u>	<u>Cap.</u>
Lower End of 108" Sewer	1,440	.0065	108"	16	1.5	21.8	111 (10%) 123 (30%) 532 (40%)	1.85 2.25 2.46	) ) 1,792)	1,020
Lower End of 9' H.S.	230	.0065	9' H.S.	14.5	0.3	22.1	111 (10%) 123 (30%) 657 (40%)	1.85 2.24 2.45	) ) 2,091)	760
Lower End of 10' H.S.	2,640	.007	10' H.S.	16	2.7	24.8	111 (10%) 123 (30%) 697 (40%) 125 (50%)	1.82 2.20 2.39 2.58	) ) ) 2,460)	1,050
Lower End of 12' H.S.	4,750	.005	12' H.S.	15.5	5.1	29.9	111 (10%) 123 (30%) 697 (40%) 335 (50%)	1.77 2.11 2.28 2.46	) ) ) 2,988)	1,445
Lower End of 14' H.S.	4,735	.005	14' H.S.	17	4.7	34.6	436 (10%) 123 (30%) 697 (40%) 540 (50%)	1.73 2.05 2.21 2.38	) ) ) 3,830)	2,150

TABLE II-A-4 (cont'd)

TABLE II-A-5

Sheet 1 of 3

PRELIMINARY COMPUTATIONS OF CAPACITIES AND PRESENT FLOW TRIBUTARY
TO NORTH BADEN SEWER SYSTEM FROM THE UPPER REACHES OF THE OPEN CHANNEL IN PASADENA HILLS
THROUGH THE COUNTY AND IN THE CITY TO ITS JUNCTION WITH THE SOUTH BADEN TRUNK
ON BASIS OF 20-YEAR RAINFALL

$n = .030$ for open channel
 $n = .012$ for new sewers; $n = .013$ for present sewers
 Park and Cemetery Property - 10% Impervious
 County Developed Area - 30% Impervious above Lucas & Hunt Rd.
 County Developed Area - 40% Impervious below Lucas & Hunt Rd.
 City Developed Area - 50% Impervious

For section above Lucas & Hunt Rd., which is now open channel, it was assumed that the upper reaches would be enclosed with pipe as shown, and that an adequate channel would be provided below the pipe section to Lucas & Hunt Rd. Below Lucas & Hunt Rd., it was assumed that the storm water facilities would consist of closing the present channel with monolithic sewer construction. The present closed sewer ends at Annie and Calvin Aves. The computations which follow are based upon the assumption of closure of the open channel as indicated with adequate sizes for the 20-year runoff. The balance of the computation is based upon the present sewer sizes.

Line	Length	Slope	Size	Vel. f.s.	t min.	T min.	A Acres	P.I.	Q c.f.s.	Cap.
Time of Concentration						10				
In Pasadena Hills above Sta. 145	1,800	.015	54"	14.5	2	12	101.2	2.28	231	
In Pasadena Hills Sta. 145 to Sta. 142	300	.04	54"	20.4	0.5	12.5	142.7	2.28	325	
Sta. 142 to Sta. 128.5	1,350	.017	Open channel, 5'w bottom, 1:2 slopes, 3.5' depth	11.0	2	14.5	220.6	2.28	503	
Sta. 128.5 to Sta. 117	1,150	.017	Open channel, 5'w bottom, 1:2 slopes, 4.5' depth	11.3	1.7	16.2	299.6	2.28	683	

TABLE II-A-5

TABLE II-A-5 (Cont.)

Sheet 2 of 3

Line	Length	Slope	Size	Vel. f.s.	t min.	T min.	A Acres	P.I.	Q c.f.s.	Cap.
Sta. 117 to Sta. 105	1,200	.0091	Open channel, 6'w bottom, 1:2 slopes, 5.5' depth	9.6	2	18.2	379.4	2.28	864	
Sta. 105 to Sta. 96, Sta. 96 = Lucas & Hunt Rd.	900	.00235	Open channel, 8'w bottom, 1:2 slopes, 7.5' depth	6.2	2.4	20.6	35 (10%) 442 (30%)	1.87 2.28	1,066	
EAST OF LUCAS & HUNT RD. (assume creek closed to present sewer)										
From Lucas & Hunt Rd. East to Ex. 8' Sewer	900	.007	10' H.S.	17.5	0.9	20.6	35 (10%) 442 (30%) 15 (40%)	1.87 2.28 2.50	1,103	
Cont. East Ex. 8' Sewer	230	.01	Ex. 8' H.S.	18.0	0.2	21.5	95 (10%) 442 (30%) 15 (40%)	1.85 2.25 2.46	1,203	900
New Sewer East from Present 8'	1,950	.008	11' H.S.	20	1.6	21.7	95 (10%) 442 (30%) 164 (40%)	1.85 2.25 2.46	1,569	1,550
East to Ex. 10' Sewer	475	.007	11½' H.S.	19.5	0.4	23.3	105 (10%) 442 (30%) 200 (40%)	1.83 2.22 2.41	1,654	1,650
To Lower End of Ex. 10' Sewer	2,355	.007	Ex. 10' H.S.	16	2.5	23.7	105 (10%) 442 (30%) 529 (40%)	1.83 2.22 2.41	2,682	1,050
To Lower End of Ex. 11' H.S.	2,460	.008	Ex. 11' H.S.	18.5	2.2	26.2	105 (10%) 442 (30%) 837 (40%)	1.81 2.18 2.37	3,130	1,450

TABLE II-A-5 (cont'd)

TABLE II-A-5 (Cont.)

Sheet 3 of 3

<u>Line</u>	<u>Length</u>	<u>Slope</u>	<u>Size</u>	<u>Vel.</u> <u>s.f.</u>	<u>t</u> <u>min.</u>	<u>T</u> <u>min.</u>	<u>A</u> <u>Acres</u>	<u>P.I.</u>	<u>Q</u> <u>c.f.s.</u>	<u>Cap.</u>
			<u>In City</u>							
To Jet. with Baden Sewer	8,450	.004	Ex. 14' H.S.	15.0	9.4	28.4	181(10%) 442(30%) 837(40%) 550(50%)	1.78 2.13 2.30 2.48	) ) ) )	1,950 4,549
<u>BADEN PUBLIC BELOW JUNCTIONS OF NORTH AND SOUTH SYSTEMS</u>										
Lower End of 18'	1,660	.0054	18' Elliptical	19	1.5	37.8	667(10%) 565(30%) 1,534(40%) 1,130(50%)	1.68 1.98 2.13 2.30	) ) ) )	3,130 8,110
Lower End of 23'	2,565	.002	23' Elliptical	12	3.6	42.9	667(10%) 565(30%) 1,534(40%) 1,390(50%)	1.65 1.94 2.08 2.24	) ) ) )	3,550 8,510

TABLE II-A-5 (cont'd)

TABLE II-A-6

SOUTH HARLEM AFTER RELIEF

Proposed Relief assumes intercepting flow from existing 12' H.S. above Belt, existing sewer above this point for max. flows would run under some head, which may require local relief.

<u>Line</u>	<u>Cap.</u> <u>c.f.s.</u>	<u>t</u> <u>min.</u>	<u>T</u> <u>min.</u>	<u>Vel.</u> <u>f.s.</u>	<u>Area</u> <u>Acres</u>	<u>P.I.</u>	<u>Q</u> <u>c.f.s.</u>
12' H.S. above Union to Belt	1,300		18.0	10	70	2.73	191
12' above Kings-highway	1,450	2.7	20.7	15.5	358	2.67	955
14' above Marcus	2,200	2.9	23.6	17.0	569	2.6	1,480
16' above Jct.	3,100	5.8	29.4	19.0	1,241	2.47	3,060

NORTH HARLEM AFTER RELIEF

Divert flow from 54" at Terminal R. R. - 52 Acres

Divert flow from 51" at Bircher - 87 Acres

Divert flow from 51½" at Bircher -155 Acres

Existing Sewer above point of interception overcharged may require lateral relief.

			10.0				
7' & 7½' Sewer	600	3.7	13.7	10	48	2.8	134
10' H.S.	880	4.2	17.9	14	286	2.73	784
12' H.S.	1,450	5.0	22.9	16.0	50(10%) 571(50%)	1.84 2.62	1,582 (May require lateral relief to Jct.)

HARLEM PUBLIC BELOW JCT. AFTER RELIEF

			29.4				
To lower end of 25' H.S.	5,690	2.6	32.0	17.4	396(10%) 2,048(50%)	1.75 2.42	5,640
Lower end of 27' H.S.	6,450	1.4	33.4	18.0	396(10%) 2,048(50%)		5,640
Lower end of 29' H.S.	7,730	1.5	34.9	18.7	519(10%) 2,458(50%)	1.72 2.38	6,740

TABLE II-A-7

BADEN SEWERS AFTER RELIEF

Proposed relief consists of intercepting entire flow at Ravenwood Ave. in Melrose Sewer District from area west, and again intercepting remaining flow at Kingshighway N.W. at Sherry Ave. from existing 10' H.S. of South Baden; then intercepting entire flow from 10' H.S. opposite Strathmore Pl., and again intercepting a portion of the flow from existing 14' H.S. of North Baden at Kingshighway N.W.

<u>Line</u>	<u>Cap. c.f.s.</u>	<u>t min.</u>	<u>T min.</u>	<u>Vel. f.s.</u>	<u>A Acres</u>	<u>P.I.</u>	<u>Q c.f.s.</u>
<u>SOUTH BADEN</u>							
			15.0				
Lower End of 108" Sewer	1,020	1.5	16.5	16.0	52(10%) 200(40%)	1.89 5.14	612
Lower End of 9' H.S.	760	0.3	16.8	14.5	52(10%) 328(40%)	1.89 2.57	935
Lower End of 10' H.S.	1,050	2.7	19.5	16	52(10%) 368(40%) 125(50%)	1.87 2.50 2.69	1,349
Lower End of 12' H.S.	1,445		15.0	15.5	260(50%)	2.8	727
Lower End of 14' H.S.	2,150	5.0	20.0	16.0	325(10%) 415(50%)	1.87 2.69	1,725
<u>NORTH BADEN</u>							
Remaining Lower End 10' H.S.	1,050	Assume 17		16.0	221(40%)	2.55	563
Lower End 11' H.S.	1,450	2.2	19.2	18.5	529(40%)	2.51	1,320
14' H.S. @ Kingshighway N.W.	1,900	3.8	23.0	15.0	79(40%) 36(50%)	2.43 2.62	) 286
Lower End 14' H.S.	1,900	5.6	28.6	15.0	76(10%) 79(40%) 346(50%)	1.78 2.31 2.49	) ) 1,178)
<u>PUBLIC BELOW JUNCTION</u>							
18' Elliptical	3,130	1.5	30.1	19	451(10%) 79(40%) 801(50%)	1.77 2.28 2.46	) ) 2,950)
23' Elliptical	3,550	3.6	33.7	12	451(10%) 79(40%) 1,061(50%)	1.74 2.23 2.40	) ) 3,511)

TABLE II-A-8

TABLE OF PRELIMINARY DESIGN FOR RELIEF SEWER IN TUNNEL
FOR THE HARLEM-BADEN SYSTEMS WITHIN THE CITY AND ST. LOUIS COUNTY

Location	Length	t min.	T min.	Unit Runoff	Acreage Inter-cepted	% of Imper-viousness	Total Flow c.f.s.	Size of Sewer	Required Hydraulic Slope	Vel. f.s.
PROPOSED HARLEM-BADEN RELIEF SEWERS										
Terminal R.R. Belt & Ashland to Terminal R.R.	1,900	1.9	26.1	1.81 2.37 2.55	55 765 363	10% 40% 50%	) (2,835)	13 $\frac{1}{2}$ ' H.S.T.	.004	17
Terminal R.R. to Bircher Ave.	2,800	2.6	28.0	1.79 2.32 2.51	55 765 415	10% 40% 50%	) (2,929)	14' H.S.T.	.004	18
Bircher Ave. to Sherry & Kings-highway N.W.	3,900	3.6	30.6	1.77 2.27 2.45	55 765 657	10% 40% 50%	) (3,442)	14 $\frac{1}{2}$ ' H.S.T.	.004	18
Kingshighway N.W. & Sherry to Kingshighway N.W. & Intersection N.Baden Sewer	5,150	4.1	34.2	1.73 2.06 2.22 2.39	166 123 1,462 782	10% 30% 40% 50%	) (5,651)	18' H.S.T.	.004	21
Intersection Kingshighway N.W. & N.Baden Sewer to McLaran & Kingshighway N.W.	2,150	1.7	38.3	1.70 2.00 2.16 2.32	166 123 1,912 986	10% 30% 40% 50%	) (6,938)	19 $\frac{1}{2}$ ' H.S.T.	.0032	21
McLaran & Kingshighway N.W. to Mississippi River	7,550	6.0	40.0	1.68 1.98 2.13 2.29	271 565 2,220 986	10% 40% 40% 50%	) (8,555)	21 $\frac{1}{2}$ ' H.S.T. (25' H.S.)	.0032	21

TABLE II-A-8

TABLE II-A-8 (Cont.)

Location	Length t min.	T min.	Unit Runoff	Acreage Inter- cepted	% of Imper- viousness	Total Flow c.f.s.	Size of Sewer	Required Hydraulic Slope	Vel. f.s.
PROPOSED BRANCH RELIEF MELROSE SEWER SYSTEM FROM RAVENWOOD AVE. TO SHERRY & KINGSHIGHWAY N.W.									
	3,700	3.1	20.3	59	10%	)	8 $\frac{1}{2}$ ' H.S.T.	.01	20
				123	30%	) 1,218			
				331	40%)			
PROPOSED BRANCH RELIEF FOR NORTH BADEN IN JENNINGS FROM ANNIE AVE. TO MCLARAN & KINGSHIGHWAY N.W.									
Intersection 10' Sewer at Annie Ave. to 10' Sewer Oppo- site Strathmore Pl.	1,900	1.7	23.3	105	10%	)	10' H.S.T.	.0065	19
				442	30%	) 1,659			
				200	40%)			
10' Sewer Opposite Strathmore Pl. to McLaran & Kingshigh- way N.W.	7,600	6.7	25.0	105	10%	)	10 $\frac{1}{2}$ ' H.S.T.	.0065	19
				442	30%	) 1,896			
				308	40%)			

APPENDIX II-B

METHOD OF DETERMINING DIMENSIONS OF FLOODWAY CHANNELS
ALONG WATER COURSES IN ST. LOUIS COUNTY

APPENDIX II-B

METHOD OF DETERMINING DIMENSIONS OF FLOODWAY CHANNELS ALONG WATER COURSES IN ST. LOUIS COUNTY

For this purpose there are available the excellent topographic maps of the inner section of St. Louis County and of the City of St. Louis. From these maps drainage areas were determined, beginning at the head waters of each of the principal streams. These areas were accumulated downstream, resulting in a tabulation showing a drainage area tributary at the junction point of each branch.

For the purpose of computation, each main water course was then divided into sections so that the tributary area within each section could not vary greatly.

Using the same maps, alignment of improved channels were worked out and profiles were plotted of the ground surface along the alignment. These profiles display the elevation of the creek bed and of the bottom land along proposed cutoff channels.

From the same maps a more detailed study was made of the elevation of these bottom lands and points were placed along the profile representative of such elevations.

There was then drawn on the profile a proposed hydraulic grade for the improved channel, placed at an elevation slightly lower than that of the adjacent bottom lands. In the preparation of preliminary plans, this hydraulic gradient was utilized as the upper limit of acceptable water surface during the passage of the ten-year flood.

There were also available land use maps and zoning maps for St. Louis County and with these supplemented by field reconnaissance a decision was made as to probable future land use and the related percentage of impervious surface that should be anticipated in each subsection of each watershed. Percentages of impervious area vary from less than 20 per cent to values approaching 50 per cent for the more closely developed sections adjacent to the City of St. Louis.

The estimated percentages of impervious surface were weighted, in terms of areas represented, and weighted values of imperviousness were carried forward in the design tables.

On the basis of judgment with regard to the economics of storm drainage of this class, the Consultants concluded that protection from flooding, under the flood expected to be equalled or exceeded once in ten years, represented a reasonable economy limit of justifiable improvement. Consequently at the lower end of each reach there has been assigned a unit runoff rate in second feet per acre (pI) representative of the rate of runoff per acre for a ten-year storm having the duration shown in the column headed "T" (Total Time to Lower End).

For more detailed understanding of the ensuing procedure, reference is made to Table II-B-3 for the Maline Creek storm water channel improvement. In this table the lengths of various reaches beginning at the watershed are indicated in the first column and in the second column the tributary area at the lower end of each reach. The third column represents the rate of water surface gradient anticipated under ten-year flood conditions. For the first five reaches these gradients were taken from a study of the rate of fall along the bottom lands adjacent to the creek; for the remaining reaches they are the hydraulic gradients shown on the profiles, Figs. II-4 and II-5.

In the column "t" are shown the calculated time of flow for each reach, and in the column "T" accumulated time of flow from the watershed to the lower end of each reach. This column was built up by assuming a system of storm sewers in Overland with a flow time of ten minutes on the surface to the initial storm inlet, and the velocity of 15 fps through the enclosed sewers for the first 15,000 feet. For the remaining reaches the time is that determined for the particular lengths and the calculated velocities in the natural or improved channels as the latter came to be designed.

In the 7th column is the weighted average of impervious surface for the whole area above and including the particular reach. The column headed pi is the estimated runoff per acre for the ten-year storm of the duration shown in column "T" for areas having the indicated percentage impervious surface. The calculated flood flow "Q" is the product of the drainage area and the unit runoff rate.

For each reach an improved channel was designed, based upon the indicated hydraulic gradient and on the general policy of deepening the creek as little as possible. In all cases the proposed channel involved trapezoidal sections having side slopes of 1 on 2. The dimensions of the sections as actually designed are shown on the plan and profile sheets.

With the sections so designed cross-sections were prepared from the topographic map at frequent intervals and the amount of excavation was computed. A reconnaissance survey was made of each creek to determine visible rock outcrops and a moderate allowance has been introduced in the estimate for a small depth of rock excavation over a limited length.

While not shown in the design table for Maline Creek, a more detailed study was made of the carrying capacity of the present improved channel within the city. It was found that this channel was ample in size but that certain of the bridges required large hydraulic head allowances to make them

In the column "t" are shown the calculated time of flow for each reach, and in the column "T" accumulated time of flow from the watershed to the lower end of each reach. This column was built up by assuming a system of storm sewers in Overland with a flow time of ten minutes on the surface to the initial storm inlet, and the velocity of 15 fps through the enclosed sewers for the first 15,000 feet. For the remaining reaches the time is that determined for the particular lengths and the calculated velocities in the natural or improved channels as the latter came to be designed.

In the 7th column is the weighted average of impervious surface for the whole area above and including the particular reach. The column headed pi is the estimated runoff per acre for the ten-year storm of the duration shown in column "T" for areas having the indicated percentage impervious surface. The calculated flood flow "Q" is the product of the drainage area and the unit runoff rate.

For each reach an improved channel was designed, based upon the indicated hydraulic gradient and on the general policy of deepening the creek as little as possible. In all cases the proposed channel involved trapezoidal sections having side slopes of 1 on 2. The dimensions of the sections as actually designed are shown on the plan and profile sheets.

With the sections so designed cross-sections were prepared from the topographic map at frequent intervals and the amount of excavation was computed. A reconnaissance survey was made of each creek to determine visible rock outcrops and a moderate allowance has been introduced in the estimate for a small depth of rock excavation over a limited length.

While not shown in the design table for Maline Creek, a more detailed study was made of the carrying capacity of the present improved channel within the city. It was found that this channel was ample in size but that certain of the bridges required large hydraulic head allowances to make them

adequate. These drops in hydraulic gradient through bridges have been endorsed on profile and Fig. II-5. It is found that even with these head losses the hydraulic grade at the city limits is sufficiently low to permit the design of adequate flood channels upstream.

Maline Creek improvements will make utilization of the half-mile of improved channel within the St. Louis city limits. A similar situation exists with respect to Gravois Creek.

However, proposed improvements to Deer Creek and from the West Fork of the River Des Peres will discharge into the very large storm water structures of the City of St. Louis, and they are dependent on these structures for the long outlet service to the Mississippi River.

To test the effect of these improvements of the River Des Peres structures in the City of St. Louis, the computation table for the West Fork of the River Des Peres, Table II-B-2, was continued through the City of St. Louis to the Mississippi River. The last four entries in this table give a preliminary estimate of the probable flood flow through these structures, for a ten-year storm, with the proposed improvements in St. Louis County in service. It will be noted that while the enclosed sewers of the City of St. Louis apparently have capacity for such a ten-year flood, the succeeding downstream open channels would be slightly overcharged up to as much as 12 per cent. This indicates that the combination of the development of denser land usage in the county area, plus provision for improved flow channels, as herein proposed, will result in certain of the city's structures being not quite adequate to carry the ten-year storm. The original design of these city structures was on the expectancy they would be adequate for a storm of as much as fifteen-year frequency. The fact must be faced that, after improved floodways

have been constructed in St. Louis County, some enlargement of the city's facilities by as much as 20 per cent may be required. This matter needs further and more careful study and it is quite possible that some such enlargement need be included in the overall drainage program.

TABLE II-B-1
DEER CREEK
Flood Flow - 10-Year Storm

	L ft.	A acres	S	V (fps)	t min.	T min.	Per Cent Imper.	pI	Q (cfs)
Lindbergh Blvd. - Mary Institute Branch	1,770	4,930	.0027	9.3	3	73	20	1.25	6,180
Mary Institute Branch - Clayton Road	2,550	5,640	.0024	9.1	5	78	22	1.20	6,780
Clayton Road - St. Louis Country Club Branch	2,350	6,180	.0035	10.9	4	82	22	1.15	7,120
St. Louis Country Club Branch - Log Cabin Country Club Branch	2,800	7,000	.0035	11.0	4	86	22	1.11	7,780
Log Cabin Country Club Branch - Litzsinger Road	3,050	7,970	.0035	11.6	6	92	22	1.05	8,360
Litzsinger Road - Two-Mile Creek	1,350	7,970	.0036	11.7					
Two-Mile Creek - Glendale Branch	2,200	13,100	.0020	9.4	4	96	27	1.08	14,150
Glendale Branch - Manchester Road	3,500	14,570	.0018	9.9	6	102	27	1.05	15,300
Manchester Road - Shady Creek	3,900	15,400	.0019	10.2	6	108	27	1.03	15,900
Shady Creek - Mo.Pac. Bridge (Sta. 120+00)	1,000	18,100	.0013	9.0	9	117	29	1.00	18,100
Mo.Pac. Bridge - Black Creek	4,250	18,100	.0014	9.4					
Black Creek - Mo.Pac. Br. (Sta. 71+00)	1,100	24,500	.0013	9.2	9	126	31	0.80	19,600
Mo.Pac. Br. - St. Louis & San Fran. Br.	5,950	24,500	.0010	17.2					
St. Louis & San Fran. Br. - River Des Peres	1,150	24,500	.0008	16.0					

NOTE: Channel improved from Lindbergh Blvd. to Mo.Pac. Bridge (Sta. 71+00) "n" = .030.
Channel paved from Mo.Pac. Bridge to River Des Peres "n" = .013.

TABLE II - B-2
FLOOD FLOW - RIVER DES PERES

Source-Term.	"n"	Length (ft.)	Aver. Vel.	Flow Time (min.)	Total Time to		Per Cent Imperv.	pI	Drainage Area Lower End (acres)	Q (cfs)	S	Capacity Present Channel
					Lower	End						
Source-Term. RR	.050	12,300	2.7	74	89		26	1.10	1,350	1,490	.0084	
RR Jct.-U. City Limits	.040	4,600	7.0	11	100		30	1.08	2,500	2,700	.0053	
U. City Limits-Olvt. Br.	.015	4,050	14.3	5	105		31	1.07	3,500	37,500	.0035	
Olvt. Br.-N & S Rd.	.015	4,550	14.9	6	111		32	1.04	4,624	4,800	.003	
N & S Rd.-Midland	.015	3,850	15.4	4	115		32	1.04	5,600	5,800	.003	
Midland-Penn. Ave.	.013	4,250	14.7	5	120		33	1.01	6,136	6,200	.0024	
Penn. Ave.-St. Louis	.013	5,120	15.0	6	126		31	.98	8,112	7,950	.002	
St. L Limits-Macklind	.013	20,100	14.0+	18	144		31.8	.93	15,400	14,400	.013	13,700
Macklind-Lindbergh	.016	15,600	14.0+	18	162		\$5.6	.89	19,900	17,700	.0011	16,400
Lindenwood-Wherry	.016	11,000	14.0+	14	176		33	.86	48,000	41,300	.0009	36,000
Wherry-Gravois Cr.	.016	14,100	13.0	14	190		34	.83	55,000	45,700	.0006	40,000
Gravois Cr.-Miss. R.	.016	6,600					(Not Computed)					

TABLE II - B -3
MALINE CREEK
Flood Flow - 10-Year Storm

	L ft.	A acres	S	V (fps)	t min.	T min.	Per Cent Imper.	PI	Q (cfs)	Re- mark	"n"
Ridge to St. Charles Rd.	3,000	160	.02	15	3	13	35	2.1	340	closed	.013
St. Charles to Creek Fork	2,700	570	.01	6	8	21	31	2.0	1,140	no imp.	.060
Creek Fork to Mat. Br. Rd.	4,000	950	.007	6	11	32	31	1.8	1,700	clearing	.040
Mat. Br. Rd. to Term. RR	3,500	1,100	.005	7	8	40	28	1.7	1,500	clearing	.035
Term. RR to Cuniff Ave. (318+00)	7,000	2,900	.0036	11	11	51	29	1.6	4,500	clearing	.035
Cuniff Ave. to W. Wabash RR	3,300	3,000	.0023	9	6	57	29	1.53	4,500	imp.	.030
W. Wabash RR to E. Wabash RR	2,800	4,400	.0023	10	5	62	30	1.48	6,500	imp.	.030
E. Wabash RR to Florissant Rd.	3,000	6,070 6,990	.0025	11	5	67	29	1.41	9,200	imp.	.030
Florissant Rd. to Hall's Ferry Rd.	9,500	7,290 8,370	.0025	11	14	81	27	1.20	9,400	imp.	.030
Hall's Ferry Rd. - Green Acres Br.	4,500	13,403 14,280	.0022	11	7	88	24	1.12	15,500	imp.	.030
Green Acres Br. - City Limits	6,200	15,270 16,240	.0020	11	9	97	25	1.05	16,500	imp.	.030

TABLE II-B-4

Sheet 1 of 2

GRAVOIS CREEKGlendale Branch

A	L	Per	t	T	Q	V	"n"
acres	feet	Cent Imper.	min.	min. 10	cfs	fs	
20	1,300	.018 35	2	12	2.1 42	9	.013
120	2,700	.011 35	4	16	2.1 250	12	Cleared
420	2,200	.011 35	3	19	2.1 880	16	Cleared
670	2,100	.0079 35	1.6	20.6	2.08 1,390	21	Paved Section-.013
860	1,950	.0085 35	3	23.6	2.03 1,750	11	Improved ch.-.030
960	1,200	.0070 35	2	25.6	2.00 1,920	10	Improved ch.-.030
1,220	3,550	.0078 35	5.4	31.3	1.91 2,330	11	Improved chn.-.030

Argonne Pl. - Mo.Pac. R.R.

Mo.Pac. R.R. - Big Bend

Big Bend - Ferndale

Ferndale - Gravois Creek

Main Gravois Creek

Gravois Creek - 440	3,380	1,700	.0041 35	2.6	33.6	1.88 6,350	11	Improved ch.-.030
440 - 383	5,030	5,700	.0034 32	8.7	42.3	1.73 8,700	11	Improved ch.-.030
383 - 355	5,630	2,800	.0039 31	4	46.3	1.67 9,380	11.7	Improved ch.-.030
355 - 289	7,500	6,600	.0021 30	11.5	58.0	1.52 11,400	9.4	Improved ch.-.030
289 - 268	7,700	2,100	.0012 29	3.7	62.5	1.47 11,200	7.8	Improved ch.-.030
276 - 255	8,200	1,300	.0019 29	1.1	63.6	1.44 11,800	19.5	Paved Section-.013

TABLE II-B-4

TABLE II-B-4 (Cont.)

Main Gravois Creek (Cont.)

	A acres	L feet	Per Cent S Imper.	t min.	T min.	pl	Q cfs	V fs	"n"
255 - 225	8,900	3,000	.0021	5	68.6	1.35	12,000	10	Improved ch.-.030
225 - 155	9,900	7,000	.0021	12.3	80.9	1.16	11,500	9.6	Improved ch.-.030
155 - 117	10,500	3,800	.0016	7.4	88.3	1.10	11,600	8.6	Improved ch.-.030
117 - 95	12,200	2,200	.0016	4.1	92.4	1.07	13,190	9.0	Improved ch.-.030
95 - River Des Peres	13,500	9,500	.0014	18.5	110.9	1.03	13,900	8.8	Improved ch.-.030

TABLE II-B-4 (cont'd)

APPENDIX II-C

LEGAL QUESTIONS AND MR. CARL TRAUBERNICHT'S OPINION THEREON

HORNER & SHIRIN
Consulting Engineers
Shell Building
St. Louis 3, Mo.

June 29, 1950

Mr. Carl Trauernicht, Attorney
408 Pine Street
St. Louis 2, Missouri

Dear Mr. Trauernicht:

General Sverdrup, Chairman of the Bi-State Development Agency, has instructed us to take up all legal questions with your office which may arise in connection with the sewer survey we are now engaged in for the Bi-State Agency in the City of St. Louis and St. Louis County areas. We realize that the present Acts of the State Legislatures of Missouri and Illinois creating the Bi-State Agency limits the function of this agency to planning and establishing policy for sewer and drainage projects. Until this law is modified, the Bi-State Agency of course cannot undertake the financing or construction of any sewer projects. The questions we wish to propound therefore do not pertain to the financing of sewer projects by the Bi-State Agency, but to financing undertaking of construction of these projects by existing agencies such as the administrative agency of St. Louis County as revised by the new St. Louis County Charter. We would therefore appreciate if you would furnish us an opinion on the following items:

1. Can the new administrative agency of St. Louis County, under the new charter, create special assessment or special tax districts for the construction of sanitary sewers?
2. Can the same agency in St. Louis County, under the new charter, also create special assessment or special tax districts for the construction of storm sewers and assess the cost in the form of tax bills against the benefited property resulting from such improvements?
3. Does the new charter permit the administrative body of St. Louis County to plan and construct sewage treatment plants, and pay for such construction by the issuance of special tax bills levied against properties which will be served by such treatment plants?
4. Does the new County charter permit the submission of a general obligation bond issue to the voters of the entire County, including present incorporated municipalities and sewer districts for the construction of sanitary and storm water sewers? If the County has such authority, is the amount of the bond issue for sewer purposes limited to a maximum of 5% or to a maximum of 10% of the total assessed valuation at the time of the submission of the bond issue to the voters of the County?
5. Can the County use such bond funds, if voted, to defray part of the cost of a joint relief sewer constructed in the City of St. Louis which serves both the County and the City?

#2

Mr. Carl Trauernicht, Attorney

6-29-50

6. Can the County administrative agency undertake the establishment of drainage districts limited to the watershed area to provide facilities for storm water runoff, with the cost of such facilities to be paid for from funds obtained through sale of bonds authorized by the property owners within the watershed only? Is this procedure possible only under present State drainage laws, which requires the institution of such proceedings by petition from the property owners and the establishment of a drainage district by the Circuit Court, with benefit assessments determined by special commissioners appointed by the Court to appraise such benefits; or does the County administrative body have the authority at present to lay out drainage districts and to submit the authorization of funds in the form of a bond issue to only the residents and property owners within such watershed, and to levy annual taxes against the property for the carrying charges covering interest, sinking fund, and maintenance?

7. Has the County the authority under the provisions of the new charter not only to establish sewer districts and construct sewer facilities, both sanitary and storm, as well as treatment plants, but has the County also the authority to levy annual taxes for maintenance of facilities?

8. Can the sewer districts now incorporated under the present State law contract with another agency for annual service charges for facilities used by them? This question is presented to cover the possibility of the construction of a trunkline sanitary sewer which would serve areas now incorporated into sewer districts or into municipalities, such construction to be carried out by the County administrative board or by the Bi-State Agency, if its present law is amended, and the financing of this construction made possible through funds contracted for with existing agencies on the basis of annual payments for service rendered by the new facilities? We understand that the Districts under the present law can arrange for purchase of existing facilities, but can they arrange for continuous annual payments for use of services constructed by others? If contracts for such annual payments are valid, it may be possible to finance the construction of trunkline facilities by an agency such as the Bi-State Agency, if its laws are changed, by the issuance of revenue bonds, the revenue to be received from the existing agencies on the basis of contracts specifying annual service charges.

9. Can a metropolitan sewer district be organized under the present laws to include the City of St. Louis and the urban area of St. Louis County, where such areas are in the same watershed and tributary to the St. Louis sewers. With the creation of such a body, the financing of the various sewers - storm and sanitary or combined - could be carried out with the funds raised by ad-valorem tax bond issues, by special tax bills, or by sewer revenue bonds, if the State Legislature authorizes such revenue bonds. We understand at present that there is no law permitting revenue bonds for sewer projects. Is this correct?

I will appreciate discussing these matters with you personally at your earliest convenience.

Very truly yours,

/s/ H. Shifrin

H. Shifrin

HS:ab

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the form of tax bills against the benefitted property resulting from such improvements?"

The powers granted, as discussed in paragraph 1 above, are not limited to sanitary sewers, and storm sewers, likewise necessary for public health, would be included in the powers granted to provide for the creation of districts for "sewers, sewage disposal facilities * * * *".

Subject to the same limitations, and in the same manner expressed above as to sanitary sewers, storm sewer districts can be created.

3. "Does the new charter permit the administrative body of St. Louis County to plan and construct sewage treatment plants, and pay for such construction by the issuance of special tax bills levied against properties which will be served by such treatment plants?"

The charter provision expressly grants power to provide for the creation of "Sewage disposal facilities".

A sewage treatment plant is a form of a sewage disposal facility and a district may be created for such purpose subject to the same limitation and in the same manner as stated above in paragraph 1.

4. "Does the new County charter permit the submission of a general obligation bond issue to the voters of the entire County, including present incorporated municipalities and sewer districts for the construction of sanitary and storm water sewers? If the County has such authority, is the amount of the bond issue for sewer purposes limited to a maximum of 5% or to a maximum of 10% of the total assessed valuation at the time of the submission of the bond issue to the voters of the County?"

The charter provisions make no reference to and grants no power to issue general obligation bonds for the entire County. The power to provide for the creation of sewer districts is limited by the charter to unincorporated areas.

The charter does provide (Article 1, Section 2) that the County shall have all the powers now or hereafter vested by the Constitution and laws of the State in County Courts.

There is no present power in County Courts to issue general obligation bonds of the whole County for sewers. If such power should be granted by the legislature to all counties of the first class, the power would then exist but not until then. Such a law would not violate any constitutional provision. Article VI, Section 8 of the Constitution of 1945, providing for the classification of counties, states: "A law applicable to any county shall apply to all counties in the class to which such county belongs."

The second part of your question is answered by saying that if and when the power is granted to counties of the first class to issue general obligation bonds of the county for sewer purposes, the provisions of Article VI, Section

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26(b) of the Constitution of 1945 permitting any county by a two thirds vote to become indebted in an amount not to exceed 5% of the value of taxable tangible property and Section 26(c) permitting any county to incur an additional indebtedness of not to exceed 5% of the value of such property, would apply.

5. "Can the County use such bond funds, if voted, to defray part of the cost of a joint relief sewer constructed in the City of St. Louis which serves both the County and the City?"

The Constitution of 1945, Article VI, Section 16, provides

"Any municipality or political subdivision of this State may contract and cooperate with other municipalities or political subdivisions thereof, or with other states or their municipalities of political subdivision, or with the United States, for the planning, development, construction, acquisition or operation of any public improvement or facility, or for a common service, in the manner provided by law."

If and when the legislature provides the manner of such cooperation and if and when the legislature permits the issuance of bonds by the County for sewer purposes, a joint relief sewer with the City of St. Louis may be undertaken.

6. "Can the County administrative agency undertake the establishment of drainage districts limited to the watershed area to provide facilities for storm water runoff, with the cost of such facilities to be paid for from funds obtained through sale of bonds authorized by the property owners within the watershed only? Is this procedure possible only under present State drainage laws, which requires the institution of such proceedings by petition from the property owners and the establishment of a drainage district by the Circuit Court, with benefit assessments determined by special commissioners appointed by the Court to appraise such benefits; or does the County administrative body have the authority at present to lay out drainage districts and to submit the authorization of funds in the form of a bond issue to only the residents and property owners within such watershed, and to levy annual taxes against the property for the carrying charges covering interest, sinking fund, and maintenance?"

Under the charter provisions the County administrative body is not permitted to lay out any districts which would include incorporated areas. The present state drainage laws, in the absence of new enabling legislation applying to all first class counties, are the only authority for laying out such districts which would include incorporated areas.

7. "Has the County the authority under the provisions of the new charter not only to establish sewer districts and construct sewer facilities, both sanitary and storm, as well as treatment plants, but has the County also the authority to levy annual taxes for maintenance of facilities?"

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The Charter gives no express authority for maintenance of sewer facilities. Section 21 provides only for the creation of districts and to pay for the facilities by special assessments or general taxes. It is scarcely conceivable that a court would invalidate a provision in the Code for the upkeep and cost of using such facility. The Code adopted by the County Council should be specific in providing for such maintenance.

8. "Can the sewer districts now incorporated under the present State law contract with another agency for annual service charges for facilities used by them? This question is presented to cover the possibility of the construction of a trunkline sanitary sewer which would serve areas now incorporated into sewer districts or into municipalities, such construction to be carried out by the County administrative board or by the Bi-State Agency, if its present law is amended, and the financing of this construction made possible through funds contracted for with existing agencies on the basis of annual payments for service rendered by the new facilities? We understand that the Districts under the present law can arrange for purchase of existing facilities, but can they arrange for continuous annual payments for use of services constructed by others? If contracts for such annual payments are valid, it may be possible to finance the construction of trunkline facilities by an agency such as the Bi-State Agency, if its laws are changed, by the issuance of revenue bonds, the revenue to be received from the existing agencies on the basis of contracts specifying annual service charges."

This question is in several parts: First, under the present sewer law in St. Louis County (Sec. 17 Laws, Special Session, 1933-34) the existing sewer districts are expressly given the power to contract with other districts or municipalities "for the construction, use or maintenance" of common sewers or disposal plants. Second, neither the County Council nor the Bi-State Agency are "municipalities or other districts" and, under the present law, there could be no contract made for use of sewers between them and the present district. The present sewer law would have to be amended to permit such contracts. Third, under the present laws the County Council has no authority to provide for a sewer district which could issue bonds predicated upon a pledge of revenues received for the use of the sewers. In fact, no authority now exists in Missouri to issue sewer revenue bonds. Such authority could be supplied by new legislation on the part of the General Assembly. Fourth, the same statements as to the authority of the County Council apply under present laws to the Bi-State Agency.

9. "Can a metropolitan sewer district be organized under the present laws to include the City of St. Louis and the urban area of St. Louis County, where such areas are in the same watershed and tributary to the St. Louis sewers. With the creation of such a body, the financing of the various sewers - storm and sanitary or combined - could be carried out with the funds raised by ad valorem tax bond issues, by special

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tax bills, or by sewer revenue bonds, if the State Legislature authorizes such revenue bonds. We understand at present that there is no law permitting revenue bonds for sewer projects. Is this correct?"

It is correct that there is not at present any law in this State which authorizes the issuance of sewer revenue bonds.

Under present laws there is no authority for the organization of a sewer district to include the City of St. Louis and parts of St. Louis County, except Article 6, Chapter 79, R. S. Mo., 1939, which on its face purports to provide for just that thing. However, that law contains the provision that bonds may be issued payable out of an ad valorem tax levied on real estate alone. This would not be a special assessment against the real estate, but would be a general ad valorem tax, levied only on real estate, whereas the Constitution, Article VI, Section 26(f) provides that before incurring any indebtedness every county, city, etc., shall provide for the collection of an annual tax on all taxable tangible property.

The law is cumbersome at best and in view of the constitutional provisions referred to, is of doubtful validity. Any action taken under it would require judicial sanction before it could be accepted in confidence.

A new legislative act could doubtless be framed which could provide for a metropolitan sewer district, the cost of which would be paid by an ad valorem tax on all tangible property within the district, and which would provide for the issuance of general obligation bonds of the district, or it might provide for special assessments on the real estate benefitted, or it might authorize the issuance of revenue bonds.

10. There is now in the statutes a law applying to counties having a population of between 400,000 and 700,000 in which is located an incorporated village, or residence district in which main and submain sewers have already been constructed or hereafter may be constructed or deemed necessary. This is the so-called Kansas City Sewer District Law.

Districts are permitted to be established by the County Court and special taxes are levied for construction and maintenance.

Assuming that the tentative 1950 census is correct, St. Louis County would fall into the classification applying to the law above referred to. There is grave doubt, however, that St. Louis County could make use of this law which classifies counties by population, which may or may not be a reasonable basis of classification. There has been a tendency on the part of the Supreme Court to invalidate such basis of classification where it can find the basis unreasonable, and it is highly probable that in this instance the Court would find that the law could not apply to St. Louis County, especially in view of the fact that under the new Constitution any new legislation cannot be based upon a classification of counties by population.

The law in question is a tax bill law and has not the flexibility and practical soundness of a law permitting the issuance of bonds.

CHARLES AND TRAUERNICHT
408 Pine Street
Saint Louis
Zone 2

October 10, 1950

Messrs. Horner & Shifrin
Consulting Engineers
Shell Building
St. Louis 3, Missouri

Attention: Mr. H. Shifrin

Gentlemen:

The following comments are submitted in response to your inquiries relating to the sewer survey of St. Louis County for the Bi-State Development Agency:

1. "Can the new administrative agency of St. Louis County, under the new charter, create special assessment or special tax districts for the construction of sanitary sewers?"

The Missouri Constitution of 1945, Article VI, Section 18, permits a county having more than 85,000 inhabitants (St. Louis County), adopting a charter, to provide for the exercise of legislative power pertaining, among other things, to "public health * * * in the part of the county outside incorporated cities;
* * * "

In accord with this constitutional provision, St. Louis County adopted a charter containing the following provision (Article 3, Section 21):

The Council shall have, by ordinance, the power "To provide for the creation of districts in the unincorporated areas of the County within which may be provided * * * sewers, sewage disposal facilities * * * and such kindred facilities as the voters therein by a majority of those voting thereon may approve, the same to be paid for from funds raised by special assessment or general taxation within such districts; * * * "

The power to "provide for the creation" of such districts by ordinance would include the power to adopt an ordinance setting up a complete code for their organization and operation. Such code might provide for the anticipation of general revenue and the issuance of bonds.

Such a code, when adopted, would require examination to determine that powers had not been exceeded and in case of any question thereon might require judicial interpretation.

It must be noted that the power to provide for the creation of sewer districts is limited by both the constitutional and charter provisions to unincorporated areas.

2. "Can the same agency in St. Louis County, under the new charter, also create special assessment or special tax districts for the construction of storm sewers and assess the cost in

- Page six -

Messrs. Horner & Shifrin

October 10, 1950

If the foregoing observations and comments open further questions, we shall be glad to hear from you again.

Very truly yours,

/s/ Charles & Trauernicht

CT:MH